REA PC-Scan with Laser Device

Barcode measuring device

User's Manual

From Software Version 3.21

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1. Introduction

The REA PC-Scan is a precision measuring device for the verification of printed bar codes of different types and accurate measurement of barcode film masters.

The unit consists of a measuring head (laser device) and a software to evaluate and display the results.
The measuring head is motor-powered, and is controlled by the evaluation software.

The evaluation software works under Windows 98, Windows NT, 2000 and XP. It performs the recognition of the individual bar code symbologies and verifies if the measurement results are in conformity with the barcode symbology specific specifications and standards.
Evaluation and display is carried out according to the traditional method using the symbology standards or specifications, together with evaluation to the CEN/ANSI method based on the international standard ISO/IEC 15416. A reflectance profile of the barcode is also displayed.

ATTENTION: Please note section 3.4 Basic calibration and section 3.5 Transport !

In order to ensure that the REA PC-Scan always provides plausible measurement results, regular **test equipment monitoring** is required as described in section 3.6.

2. Equipment of the REA PC-Scan

The REA PC-Scan is supplied with the following accessories, packed in a case:

- Laser device. This is the measuring device
- A pressure plate
- 4 hex-head screws with the corresponding allen key
- Power supply unit with data cable for connection to the PC
- Primary adapter (EURO, US or UK). The primary adapter is attached to the power supply unit.
- Operating instructions
- Test code on photographic paper with a verification report
- Equipment case with inlay for the REA PC-Scan
- A CD-ROM with the REA PC-Scan evaluation program and the operating instructions in PDF format

Options:

- The laser device is available in a version with a measurement length of 155 mm (standard) or 240 mm (optional). There are two different measurement wavelengths: 670 nm (standard) or 635 nm (optional). Both must be defined at the time of ordering. Any later change means that the device must be replaced.

- Optional symbologies: The optional symbologies are provided by another software version. The version with optional symbologies also includes only one CD-ROM, although the contents are different.
- Film measurement: Two calibration films are required for film measurement. These are used for so-called film calibration (see section 4.8.3.1.4).

- Round shaped bodies adapter: The round shaped bodies adapter is a special base plate made of aluminium with an integral prism for the measurement of barcodes on rounded surfaces. In order for the round shaped body adapter to be used, the barcodes must be printed in picket fence direction.

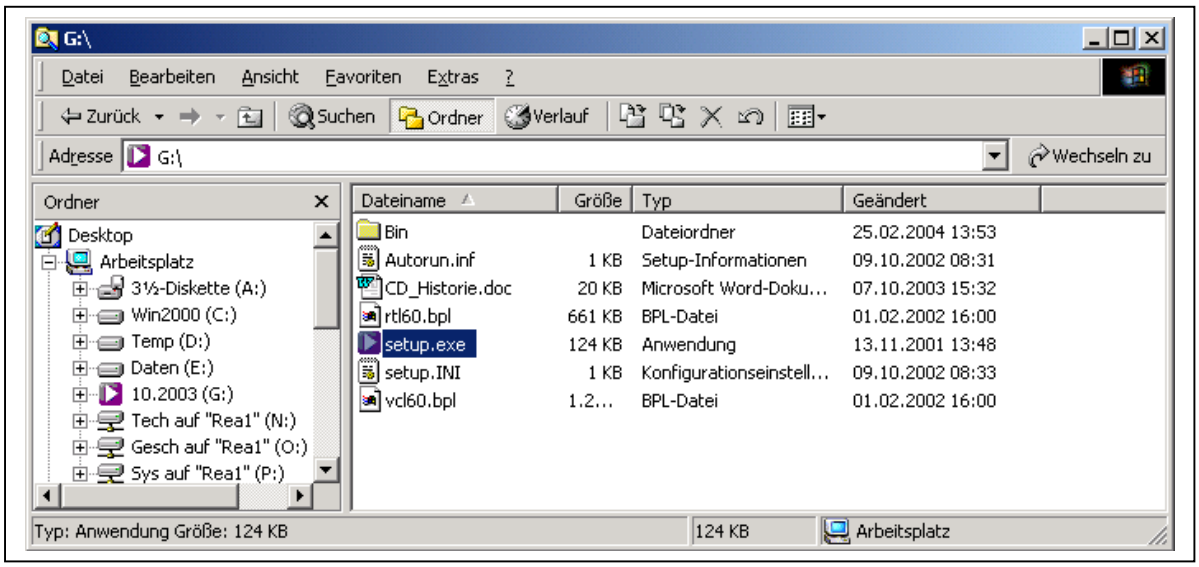
With the exception of the operating instructions, the accessories supplied with the standard version are listed on the delivery note as one complete item – the REA PC-Scan. Different measurement lengths and measurement wavelengths are specified under this main item.
The other options appear as separate items on the delivery note.

3. Commissioning the REA PC-Scan

The commissioning of the REA PC-Scan consists of the software installation on a PC and the connection of the laser device to this PC. Normal PC's no more than 5 years old with a free serial port (COM1 to COM4) offer sufficient computer performance and memory capacity for the operation of the REA PC-Scan.

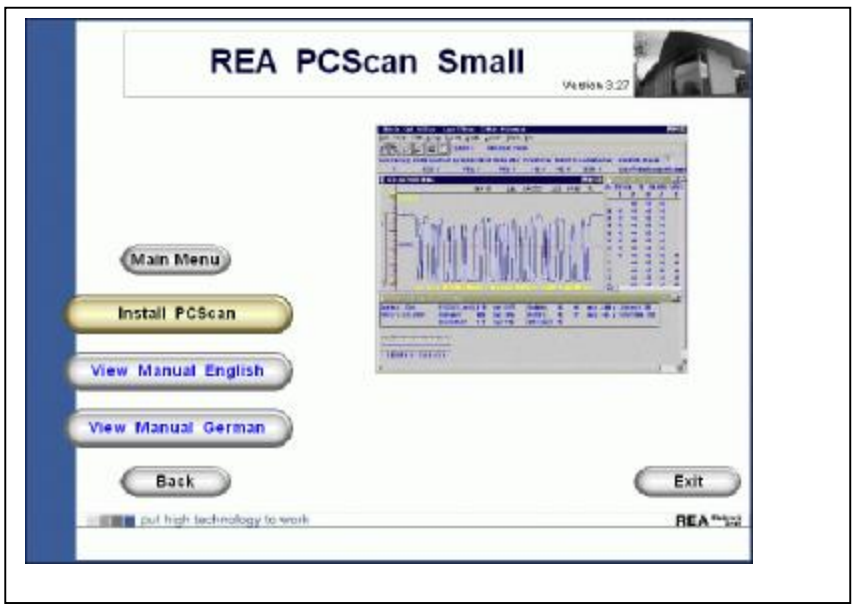
3.1 Software installation

For the software installation, insert the enclosed CD-ROM into a CD-ROM or DVD drive. If the auto start function is active, the installation routine will start automatically. If auto start is switched off, this must be done manually with Windows Explorer.



To do this, select the CD-ROM drive (here G:). On the CD-ROM, run the file Setup.exe by double-clicking it with the mouse. The following screen then appears:

In order to install the software, click the button "Install Software" with the mouse. The following screen now appears:



To start the installation, click the button PC-Scan SMALL or PC-Scan Full, depending on the version. This opens a screen in which the PC-Scan version can be started with the preset languages German, English, French or Spanish.

Users of Windows 2000 must install Microsoft TweakUI before the PC-Scan installation. For Windows 2000, at least Service Pack 2 from Microsoft must also be installed in advance.

The further installation is self-explanatory. If an older PC-Scan version has been installed, this should be deleted before the new installation. Alternatively, a new folder can be selected as the destination folder instead of the suggested folder. At the end of the installation, the Readme file can be displayed, which briefly describes the changes from version to version. The installation is then completed, and the DemoShield from which the installation was started can be closed by clicking Exit.

Further programs such as TransWin and Article Database can also be installed from the CD. This is intended for REA Check 3 and REA ScanCheck II, and is not needed for REA PC-Scan.

The REA PC-Scan software can be started from the desktop icon or via the start menu.

3.2 Hardware installation

Only a few steps are required for the hardware installation of the REA PC-Scan. First remove the laser device from the case. The pressure plate must be attached to the underside of the REA PC-Scan laser device using the hex-head screws supplied.

If barcodes on rounded surfaces are to be measured, the round shaped body adapter is required. The round shaped body adapter is a pressure plate made of aluminium with an integral prism.

The cable of the REA PC-Scan is fitted with a 25-pin SUB-D connector.

This male connector is fitted to the corresponding socket on the power supply unit of the REA PC-Scan.

Plug and socket connectors

Connectors fitted together

ATTENTION: The connectors must not be fitted together when the power supply unit is connected to the power supply. This may severely damage the circuits.

This leaves the power supply unit and a 9-pin plug. The power supply unit can now be connected to the power supply.

The 9-pin plug is connected to a serial port (COM Port) of the PC.

The REA PC-Scan is now ready for operation. After pressing the ON button, the green LED lights up.

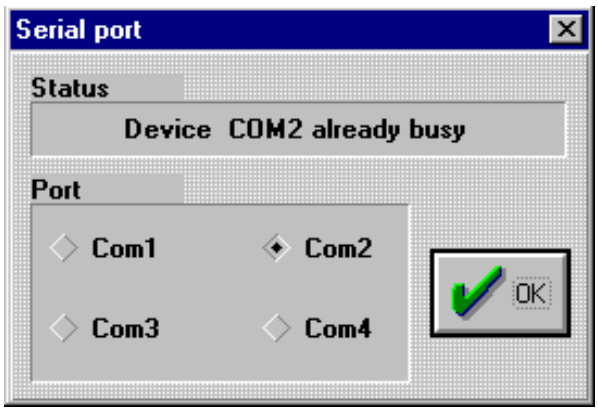
The software is started either by double-clicking the desktop icon or via the entry in the start menu. First the basic calibration is carried out (see section 3.4) and the correct serial port selected.

3.3 Serial port

The communication between the REA PC-Scan laser device and the REA PC-Scan Windows software takes place via a serial port. Serial ports are also referred to as COM ports in the PC environment. Most PCs have two serial ports, COM1 and COM2. The REA PC-Scan Windows software uses COM2 as default setting. If the REA PC-Scan Windows software starts and the main screen appears without any error message, the REA PC-Scan laser device has been recognised. If the message "Can't open COMx" appears, this means the port is not available. In such a case, either the port does not exist, or is already being used by another program, such as a fax program for an analog modem, PDA software or similar.

If the REA PC-Scan laser device cannot be found, the following error message appears: "No Laser device found. Select another port or check interface cable".

In this case the cabling must be checked, and the REA PC-Scan laser device checked to make sure it is switched on. In the simplest case, the incorrect port has been selected in the initial setting.
The selection of the port is made in the menu Options/Serial port.



Four ports are available for selection. COM3 and COM4 are normally only available if an extension card has been installed, or if a converter cable from USB to serial has been installed.

If the communication between the device and the PC fails to function, the following points must be checked:

- Cabling: Is the cable correctly connected to the device and the PC. The cabling must be connected as described in section 3.2.
- Port occupied: Is "Can't open COMx" displayed? If this is the case, the selected port cannot be used. Either the program using the port must be closed, or another port must be selected.
- Hardware faults: Hardware faults can include a break in the cable, or the port components in the PC or device may be defective. In such a case, test the system on another PC. If none of the problems described above apply, such a fault may be present, and the device must be repaired.

Nowadays PC's, and especially notebooks without serial ports, are produced with USB ports instead. In such a case, the simplest solution is a converter cable from USB to serial in order to connect and operate the REA PC-Scan with such a PC. These cables are available from your specialist computer dealer.

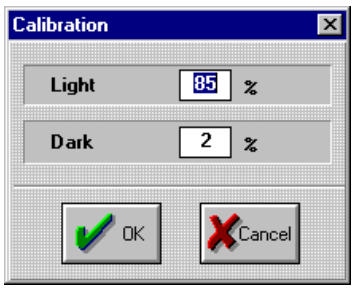
3.4 Basic calibration

ATTENTION: This is a basic setting which only needs to be done or checked once after installing the device or after a repair. If the settings are wrong, incorrect contrast values will be displayed!

The white and black calibration for the corresponding laser device is made in the menu Options/Calibration.

On the back of the laser device is a label, which shows the two values for "White" (Weiß) and "Black" (Schwarz).

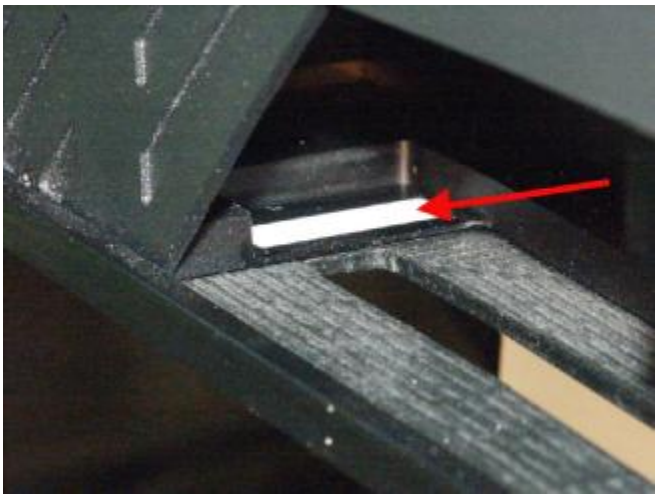
These values must be entered under "Light" and "Dark".



These values must only be changed if another laser device with other calibration values is connected to the PC. In case of maintenance or repair, these values will be checked and possibly corrected, and must then be checked again after re-commissioning.

No calibration by the user is required. The REA PC-Scan must be checked regularly in accordance with the instructions on the enclosed sheet containing the test code. If the measured values fall outside the tolerance, the device must be repaired. If the contrast values fall outside the tolerance, the calibration fields should first be cleaned.

The calibration fields are located at the inner left of the device, as shown in the illustration:



If the contrast values still lie outside the permissible tolerances after cleaning, repair with works calibration is required.

Further instructions on calibration are given on the enclosed sheet containing the test code.

ATTENTION: The calibration fields must be cleaned only with a damp cloth and washing-up liquid. The use of solvents will cause damage necessitating factory repair!

3.5 Transport

The REA PC-Scan must only be transported in the case supplied.

Push the carriage to the left.
Remove the pressure plate

Never leave the carriage
in this position

The carriage must also be held in place with the plastic clip provided.

Clip on device

The REA PC-Scan laser device must be placed in the case only as shown below.

Never transport or send the device without the case. All guarantee claims are invalid if the device is sent without the case!

These transport instructions must be followed in order to prevent the carriage moving freely during transport. If the carriage is free to move it will be prone to damage by violent movements. In such a case, the drive of the carriage (gears and motor) is almost invariably destroyed.

3.6 Test equipment monitoring

The REA PC-Scan is always supplied with a test code on photographic paper. This test code is affixed to a DIN-A4 sheet. The permissible tolerances of the device are also specified on this DIN-A4 sheet. The sheet also describes how the measurement results are related to national standards. A verification report on the test code is also provided, which has been produced from the enclosed test code by an REA PC-Scan reference device.

The test code should be measured once per month and the results compared with the results on the reference report. If the deviations become greater than the permissible tolerances, this means the device requires maintenance. In the simplest case, it may only be necessary to clean the calibration fields (as described in section 3.4).

The test code must be stored protected from light. Scratches, marks and other damage must be avoided. REA Elektronik GmbH guarantees a working life of 2 years for this test code, provided that the handling instructions are followed.

4. Using the REA PC-Scan

This chapter describes the use and operation of the REA PC-Scan.
We will start with the most important points. This is followed by details of the operation in the sequence of the menu structure.
It should be noted that the REA PC-Scan is designed to measure barcodes. The measurement results must be reproducible and comparable. All measurements must therefore be performed under constant conditions. The angle and distance of the REA PC-Scan to the test object must always remain the same.

This requirement does not exist for a barcode scanner. This is due to the purpose of a scanner. The barcode scanner must recognise barcodes as efficiently as possible and under the most variable conditions as possible, and thus make the decoded data available for the logistics process.

4.1 Operation of the REA PC-Scan

The following instructions on operation must be observed in order to achieve comparable and reproducible measurement results:

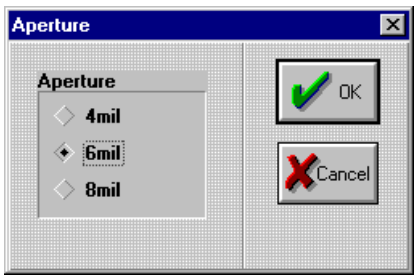
1. The laser beam must cross the barcode at an angle of 90°. If not, the device will display incorrect barcode sizes.
2. The barcode must lie flat under the device. If not, the contrast results will vary. This is particularly critical in the case of metallic or glossy materials.
3. The distance from the barcode must always remain the same. The ideal distance is achieved when the REA PC-Scan stands on a perfectly flat surface. The REA PC-Scan has a tolerance range of 6 mm for this distance.
4. Measurements in direct sunlight or with heavy shadow in the measurement area must be avoided, since this will falsify the measurements.
5. If there is more than one code in the scanning area, the first code from the left will always be recognised and measured. It may therefore be necessary to cover codes in order to measure the required code.
6. The laser device must not be allowed to fall or be exposed to severe shocks or impact. This may lead to damage to the gears that drive the carriage. In the event of such damage, the smooth movement of the carriage will be blocked or the movement may stick at certain points of the measurement path.

Measurements of barcodes printed on thin plastic film may in unfavourable cases produce varying results. Firstly, it must be ensured that the film lies perfectly flat under the device. If measurements are being performed on such things as finished crisps packets, the user must try to maintain the ideal condition of "perfectly flat" as far as possible. Since this is very difficult, REA Elektronik GmbH recommends that such films are always measured as samples placed flat on a defined substrate (according ISO/IEC 15416: black, max. 5 % reflectance).

Transparent or semi-transparent films with a white field behind the barcode can also produce varying measurement results if these films are measured against a white substrate. This is due to the fact that the distance between the film and the substrate is never the same, and that the distance has greater effect on the modulation parameter with increasing transparency. This effect is based on the fact that a light substrate reflects light, and that films as described let through this reflected light.

4.2 Aperture setting

The REA PC-Scan laser device sets the measurement aperture with the aid of a point of light from a laser beam with a defined geometry. The physical aperture resulting from this technique has a size of 4 mil (corresponding to about 0.1 mm or 100 µm).



The setting menu can be found under Options/Aperture. To make the setting, click the required checkmark and confirm the setting with OK. The measurement aperture will be shown at the upper edge of the REA PC-Scan window. The measurement aperture will also be shown on every verification report.

The apertures 6 mil and 8 mil are calculated with the aid of a mathematical interpolation process. The advantage of this process is an easier operation of the device, without the need for an adjustment before every measurement.
The disadvantage is that this procedure does not produce an ideal, circular aperture geometry, but instead an oval. For the 4 mil aperture, the oval is vertical. 6 mil produces almost ideal conditions. 8 mil has a horizontal oval. The resulting measurement accuracy is specified on the enclosed sheet with the test code.

According to standard ISO/IEC 15416, the aperture (and thus the size of the laser spot) should not be larger than 80 % of the X-module. This information can be obtained as an extreme case from table 1 in section 5.2.2 of ISO/IEC 15416. The X-module is by definition the nominal width of the narrow elements (bars and intermediate spaces) in a barcode symbol.
On the basis of this definition, the X-module should not be smaller than the following values:

4 mil (100 µm)	X >=	125 µm (0.125 mm)
6 mil (150 µm)	X >=	187 µm (0.187 mm)
8 mil (200 µm)	X >=	250 µm (0.250 mm)
10 mil (250 µm)	X >=	312 µm (0.312 mm) not available with REA PC-Scan
20 mil (500 µm)	X >=	625 µm (0.625 mm) not available with REA PC-Scan

1 mm is 1000 µm, 1 µm is 0.001 mm, 1 mil is 25.4 µm or 0.0254 mm.

Large symbols with large X-modules can basically always be read and checked with an aperture smaller than the assigned one. On the other hand, small codes should never be measured with a too large aperture.

For EAN codes, the following apertures are specified by GS1 International:

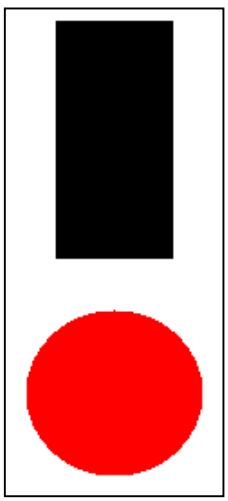
EAN 8 EAN 13 UPC-A UPC-E	all sizes	6 mil
EAN 128	all sizes	10 mil
ITF 14	X < 0.635 mm	10 mil
ITF 14	X > = 0.635 mm	20 mil

Older specifications contain the following values:

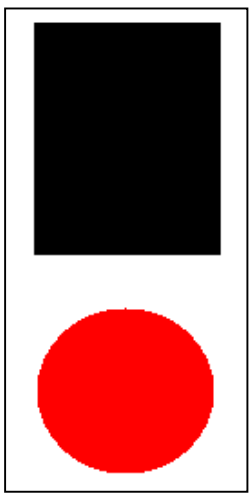
EAN 8/13	6 mil	80 % - 99 %
	8 mil	100 % - 150 %
	10 mil	151 % - 200 %
EAN 128	8 mil	25 % - 49 %
	10 mil	50 % - 69 %
	20 mil	70 % - 100 %
ITF 14	10 mil	50 % - 69 %
	20 mil	70 % - 101 %

In a closed application, the measurement aperture can be determined by means of the scanner aperture. The aperture should be smaller or at most the same, as the scanner aperture.

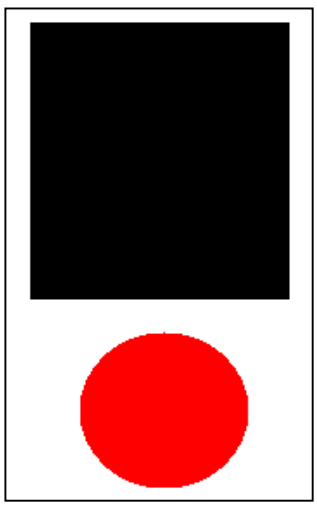
If the aperture size is too big then the size of the laser light dot is larger than a small bar or space. The edge contrast and modulation will be decreased. If the aperture size is smaller than required by the guide lines above then this is not critical if the code is printed to a reasonable quality. Defects will appear with a larger value.



Aperture too large



Aperture = Module width

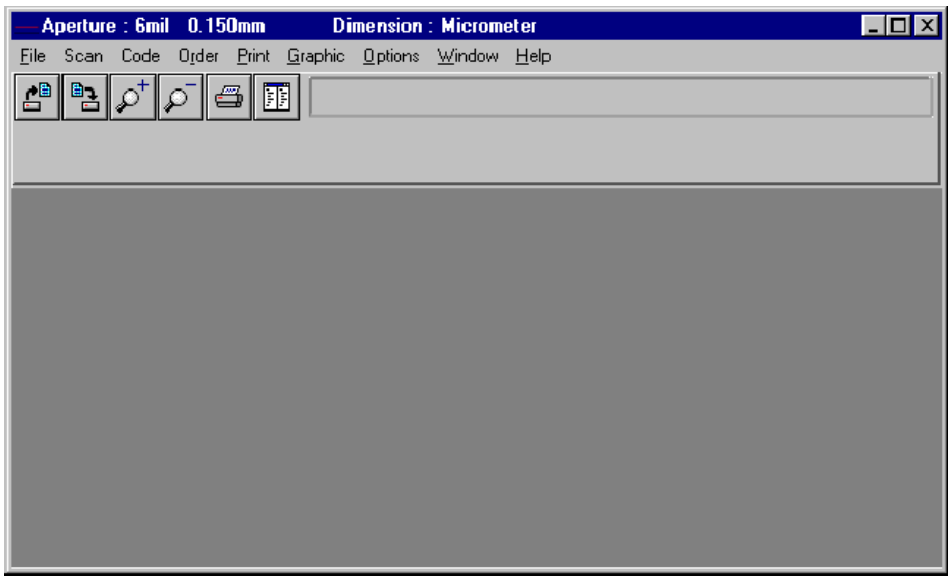


Aperture no larger than 80 % of X

In the setting Film measurement (see section 4.8.3.1.4), the measurement aperture is set at 4 mil, and cannot be changed.

4.3 Measuring a barcode

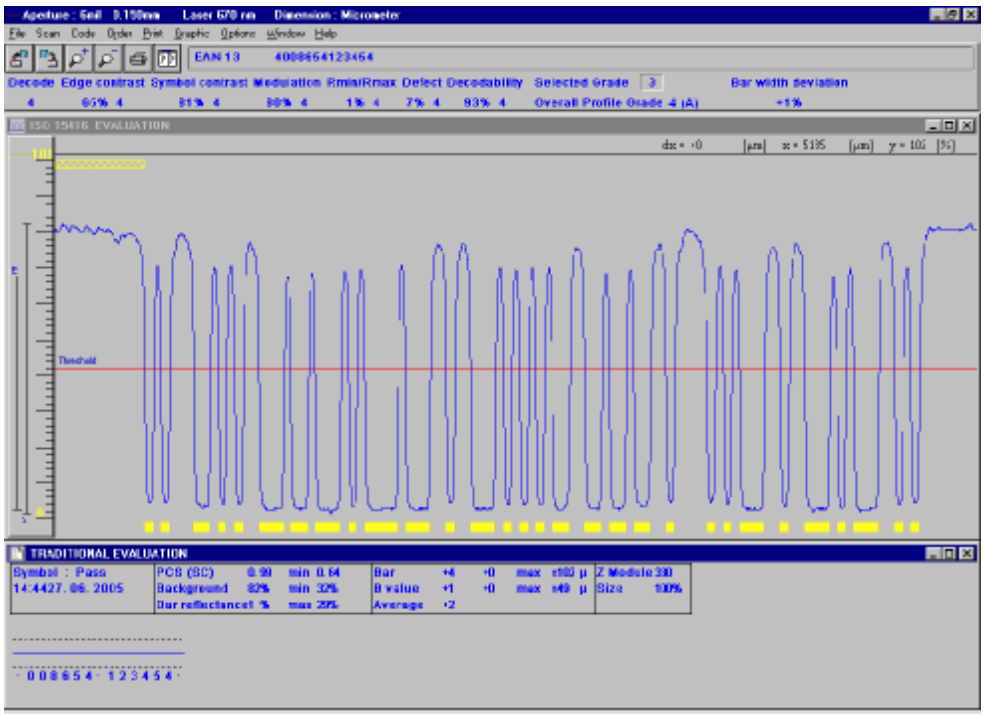
Following installation and basic calibration, measurement operations can begin. First start the software. If no error message appears, this means that the REA PC-Scan laser device has been recognised and is ready for measurements.



The software first appears as in the above illustration.

In accordance with the operating instructions in section 4.1 the REA PC-Scan laser device must be placed on the barcode. The measurement is started by pressing the SCAN button on the REA PC-Scan laser device. The measurement can also be started by pressing the spacebar on the PC keyboard, or by mouse in the measure menu.

Following the measurement, the measurement result with the individual test parameters of the measurement appears in the window of the REA PC-Scan software.



The overall result is assessed by means of <u>two</u> screen positions:

<u>Top right:</u> Scan reflectance profile grade (result of the CEN/ANSI evaluation)
Here a result appears classified from Grade 0 (error) to Grade 4 (very good).
If a multiple measurement is carried out, the text Overall symbol grade appears instead of scan reflectance profile grade. The minimum quality is defined by setting the selected grade. If the determined grade is smaller than the selected grade, the measurement result will be evaluated as an error, and shown in red.

<u>Bottom left:</u> Symbol error or pass
This is the result of the traditional evaluation. Only "Pass" or "Fail" is shown as the result.

The traditional evaluation and the CEN/ANSI evaluation are separate, independent methods. The results may therefore be different.

The procedure described in this chapter is adequate for the pure assessment of whether a barcode symbol lies within or outside the required specifications.

The explanations for the operation of the menu bar and the pictograms, by clicking with the mouse, are described in sections 4.8. "PC-Scan menu bar on the monitor" and "Icons" 4.8.9.

For the basic functions of bar code verification only the buttons on the laser device are required.

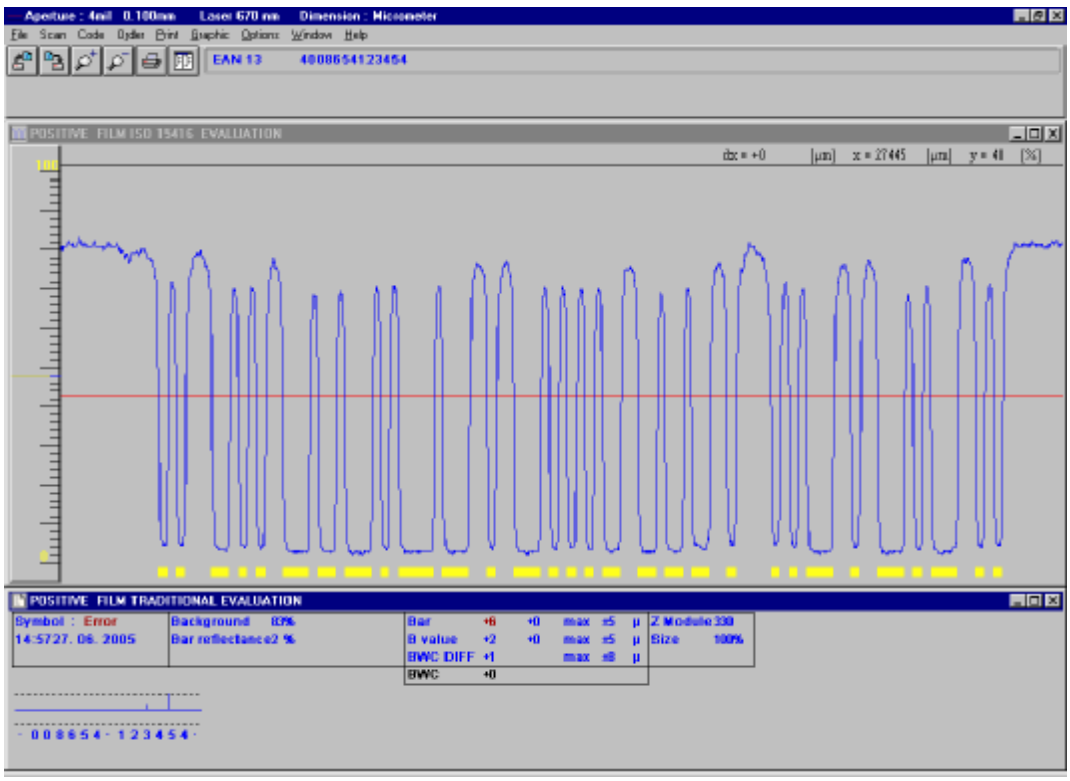
4.4 Measuring a film master

In order to measure a film master, the system must first be switched from printed codes to film or digital film. This procedure is described in section 4.8.3.1.4. Before measurement can be started, film calibration is necessary, or more correctly, calibration for the necessary white measurement substrate. The description of film calibration can be found in section 4.8.3.1.5.

After these preparations, the measurement of the films can be started. The films must be placed on the previously calibrated substrate and "smoothed out". In order to achieve the best possible measurement accuracy, the film must lie as closely as possible on the substrate. In order not to damage the films and help them to "stick" to the substrate by electrostatic charge, the wearing of thin cotton gloves is recommended. The films must not be contaminated by fingerprints. When the films are smoothed out onto the substrate, static electricity is built up, which causes the film to stick to the substrate. The REA PC-Scan laser device is then placed on the film. The laser must cross the bars at an angle of 90°. The required bar width correction for the printing process must be set (see section 4.8.3.1.4). As for printed barcodes, the measurement is started by pressing the Scan button, spacebar or by menu. A positive film or negative film traditional evaluation is displayed as the result.

ATTENTION: The CEN/ANSI evaluation to ISO/IEC 15416 is not needed, since the results are partly nonsense and partly misleading.

The measurement results are similar to the traditional evaluation for printed codes.



The first and most important check is the symbology and the code content. The next check is the setting of the bar width correction (BWC) value (appears black on the screen). In case of an incorrect setting, the initial setting should be corrected (see section 4.8.3.1.4) and the measurement repeated. The correct size of the bar code symbol is checked by control the correct value for the Z-module. The process continues with a check of the bar width correction. The BWCDIFF figure should ideally be 0. If this is the case, the preset bar width correction (BWC) matches the measured bar width correction. The permissible tolerance, depending on the setting, is ± 8 µm (film) or ± 16 µm (digital film).
If this is in order, the bar width deviations are checked. The display of the two bar values is identical to the display for printed codes. As for printed codes, these are two extreme values, which display the variation range of the bar widths. The difference is the reference point. In the case of printed barcodes, the measurement always assumes the ideal bar widths calculated from the Z-module, and then determines the variation from these ideal widths. In the case of film measurement, the reference point for the bar variations is the ideal bar width, less the bar width difference (BWCDiff). With a bar width reduction, the reference dimension therefore becomes smaller, and with a bar width increase, the reference dimension becomes larger. The measurement obtained produces variations of the bar widths around the measured reduction value. If space information is available, the procedure is exactly the opposite to bar widths. B-values or E-values (total of adjacent bars and spaces) are not affected by the bar width correction, because the dimension by which the bar is changed is added to the size of the spaces. The total of bar and space widths thus remain constant. If these checks all remain within the permissible tolerances, the film master is evaluated as "Pass", and otherwise as "Fail".

The figures for "Light" and "Dark" are for information only, and are not used in the evaluation. If the bars become too light, this is a case of a film in which the black areas are showing through. If the spaces become too dark, then the film is letting through too little light, or the measurement substrate is too dark.

4.5 Using the round shaped bodies adapter

The round shaped bodies adapter is an alternative pressure plate which facilitates the measurement of barcodes on rounded surfaces.

Measurement with the aid of this plate is only possible if the barcodes are printed picket fence. The integral prism enables simple attachment of the test objects.

If barcodes are to be measured on such rounded surfaces, the REA PC-Scan laser device should be placed on its back. For safety reasons, the base plate should always point away from the user.

The above illustration shows the view from the rear or inside, with the REA PC-Scan lying on its back. For a clearer view, the round shaped bodies adapter is shown with a normal PET bottle.

The tongue circled in red in the illustration is an additional support. This tongue should be used as the only support surface particularly for small tubular objects from about 15 mm. If such small tubular objects are placed against the left or right edge, the required attachment of the test object is no longer possible.

ATTENTION: The barcode to be measured must never lie in the area of the tongue circled in red.

4.6 Function buttons on the laser device

All necessary basic functions can be carried out with the buttons.

ON	=	Turns the laser device on or off
Scan	=	Initiate the measurement
Store	=	Store a measurement
Print	=	Print the evaluation report
POS	=	Positioning of the laser beam

4.6.1 Operation of the PC-Scan with the laser device

After switching on the laser device with the ON button on the reader head, the standard functions necessary for the measurement of barcodes can be carried out using the buttons on the reader head. The same functions can also be started from the PC.

4.6.2 Scan button - Barcode measurement

The measuring process is initiated by pressing the "Scan" button. The carriage with the laser moves from the left to the right over the barcode symbol to be verified and then moves back to its rest position. The first decodable barcode in the measuring path will be measured and the measuring results displayed on the monitor. During a measuring process the red LED above the "Scan" button is illuminated.

4.6.3 Pos. button - Positioning the laser beam

In the rest position, the laser is switched off, and the correct positioning of the reader head may therefore be difficult for small barcodes.
By pressing the Pos. button, the carriage moves approx. 2 cm to the right, and the laser is switched on (position "Laser on"). The laser dot can now be positioned immediately in front of the barcode. By pressing the button again briefly, the carriage returns to its rest position, and the measurement process is started by pressing the Scan button.
If the Pos. button is pressed for longer or held down, the carriage will travel the full measurement path. From the position "Laser on", it is also possible to switch direct to the measurement with the Scan button, without first sending the carriage back to its rest position.

4.6.4 Print button - Report printout

A printout of the measurement report may be generated by pressing this button. The report form (CEN/ANSI or Traditional, scan reflectance profile grade and/or detail values) must be set in the menu bar, see section 4.8.5.2 Print options for report printout.

4.6.5 Store button - Store measurements

After measurement of a barcode and display of the measurement values on the monitor, the values can be stored by pressing the Store button.
The storage process and file name are displayed briefly in a separate window. Every stored report is automatically assigned a file name, which is made up as follows: e.g.: M24AUG04.007. This is the 7th storage process, and the measurement was carried out on 24th August 2004. If the option "Store text file" is active, a text file will be created additionally. The file name has the same format, except for the first letter "T" for text instead of "M" for measurement.

Test reports with the designation "M" use the REA PC-Scan internal file format. This can be loaded again from the REA PC-Scan software and displayed. The text format can be displayed with text processing.

In the initial setting, all verification reports are stored in the sub-directory DATA of the REA PC-Scan installation directory. If the path is to be changed, a report must be saved to a new directory by selecting "Save as". The new path then also applies for the STORE function.

4.7 Acoustic signals

After a measurement the following acoustic signals may be heard:

1 x beep	=	Successful decoding and measurement
2 x beeps	=	Decoding attempt not successful. The message "Not decoded" is displayed
1 x beep plus 2 x beeps	=	Successful decoding, but there is some kind of error in the symbol
1 x beep plus long beep	=	Multiple measurements completed

4.8 PC-Scan menu bar on the monitor

4.8.1 File

Save measurement
The measurement is saved under a freely-selectable file name. The file names must follow the MS-DOS/Windows 3.11 convention, with 8 characters and 3 character extension (see also Icon 2). The measurement data saving can be configured so that the data are saved as text or as a table (CSV) (see section 4.8.7.16 and 4.8.7.17). If reports shall be read by several users, or if reports are to be sent by email, the use of a program for creating PDF files is recommended. Such programmes appear as printers, and in this case a report is created by means of the print function.

Open measurement
A saved measurement will be loaded again (see also Icon 1).

Traditional detail evaluation
The window with traditional detail evaluation will be displayed (see also Icon 6).

Error
The window with error messages will be displayed. This function is only available if an error message has been generated (see also Icon 8).

Close
The PC-Scan program will be closed.

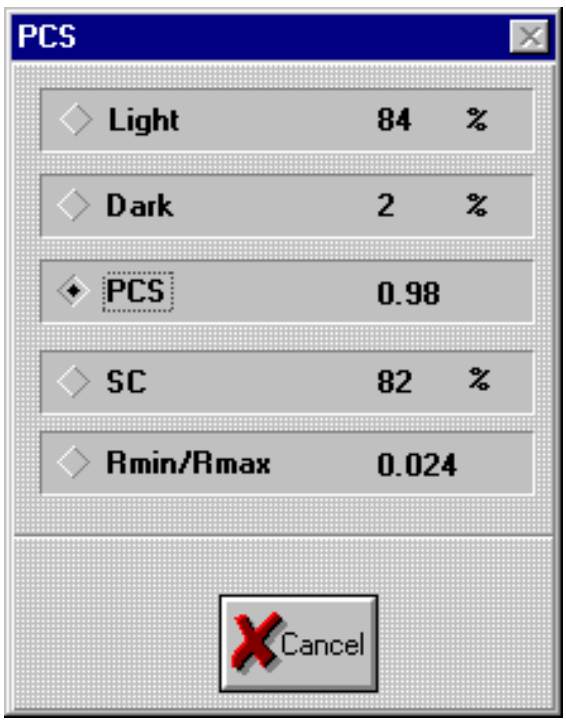
4.8.2 Measure

This menu item includes two sub-items. "Measure" initiates the actual measurement process. The measurement process can also be started by pressing the spacebar on the keyboard or the "Scan" button on the laser device. The description of the second item PCS is in the next chapter.

4.8.2.1 PCS - Static reflectance measurement

The sub-item "PCS measurement" initiates a static reflectance measurement. A light or dark value can be determined. These two reflectance values are used to determine the PCS (Print Contrast Signal) value, the barcode contrast and the ratio R_{min}/R_{max}.

This function is useful to check the reflectance values of colours, before the barcode is printed. The following window appears on the monitor:



First the light value is marked by the black dot in the checkbox. The laser spot is now positioned on the required background colour. The dark value is then clicked with the mouse, and the laser spot placed on the required bar colour. If PCS, SC or R_{min}/R_{max} is then clicked with the mouse, the calculated values from the two previous statically measured reflectance values are displayed.

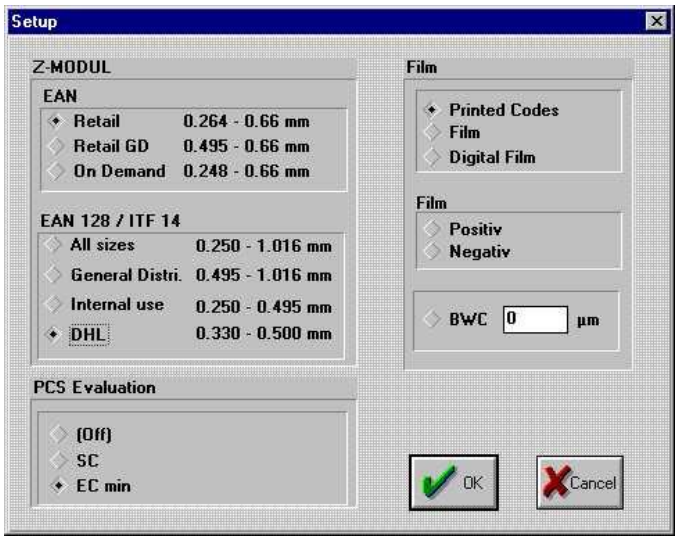
For accurate positioning of the laser beam on very small printed areas, the carriage can be moved to the left or right in small steps by briefly pressing the "Store" button or "Pos." button respectively.

4.8.3 Code

This menu item includes two sub-items. Setup allows a series of preliminary settings. "Selection" is the dialogue for activating bar code symbologies jointly or individually.

4.8.3.1 Initial settings

The initial settings are accessed under "Setup". The following dialogue window appears:



Z-module
The Z-module is a specialist term for barcode sizes. The Z-module defines the nominal width of the narrow elements (bar or spaces) or modules in a barcode. Bars or spaces thicker than Z-Module have usually only widths in whole multiples of the Z-module. For barcode symbologies with only two bar widths the thicker elements are calculated as multiples of Z-Module and a ratio value. Further details are given in section 7.2.1.3.

GS1 International (formerly EAN International), defines size ranges for the GS1 barcode symbologies in the EAN General Specifications. These EAN General Specifications define different size ranges for EAN codes, depending on the application. For the retail trade, the size range is between 80 % and 200 % (or a module width from 0.264 mm to 0.66 mm). This is at the same time the size range definition of the EAN/UPC symbology standard ISO/IEC 15420.

GS1 define a further size range for General Distribution. This refers to EAN/UPC codes on outer packaging, palettes and the like (generally on transport packaging). In this case, only the size range from 150 % to 200 % is allowed (or in module width 0.495 mm to 0.660 mm). In a footnote to the EAN General Specifications the range from 75 % to 80 % is also allowed. This applies with restrictions to print-on-demand. Print-on-demand is usually label printing in the fresh goods sales area for products such as fresh fruit, vegetables or meat or cheese. These labels are normally printed using thermal-direct printing.

These printers usually have a resolution of 200 or 300 dpi. At these resolutions, a possible size for the EAN code is 75 to 76 %. The next possible size step is either 113 % or 102 %. This is usually too large while 75 % is out of the normal specification.
ISO/IEC 15420 does not allow the size range 75 % to 80 %. This will possibly be changed at the next revision of the standard.

In order to be able to perform measurements to these specifications, the REA PC-Scan offers three different setting possibilities:

Retail
0.264 mm to 0.66 mm (or 80 % to 200 %)

This is the standard setting for the retail trade according to ISO/IEC 15420

Retail GD (General Distribution)
0.495 mm to 0.660 mm (150 % to 200 %)

This is the standard setting for EAN codes for transport packaging and transport labels.

On Demand (Retail print-on-demand)
0.248 – 0.66 mm (75 –200 %)

This complements the size range for the retail trade by the range 75 % to < 80 % for on-demand printing.

4.8.3.1.1 Size specification for EAN 128 codes (EAN 128 SIZE)

In the same way as for EAN/UPC codes, GS1 also defines certain size ranges for EAN 128. The complete range lies between 0.25 and 1.016 mm. This is sub-divided into two ranges. The first range is intended for internal applications or for agreed applications between two parties. This is the range from 0.25 to 0.495 mm. The range from 0.495 to 1.016 mm is provided for General Distribution.

In order to meet these specifications, REA PC-Scan offers 3 setting possibilities:

All sizes
0.25 to 1.016

This setting is used if no special restrictions on the complete range are required.

General Distribution
0.495 to 1.016 mm

This setting is used for codes on transport packaging, palettes and the like. This is the default setting.

Internal Use
0.25 to 0.495 mm

This setting is intended for internal EAN 128 applications.

The "odd" number value of 0.495 mm was defined as the limit in order to define a standard lower limit for EAN 13/EAN 8 codes on transport packaging and EAN 128 and ITF 14. This odd number value results from the enlargement factor of 150 % applied to the EAN 13 code.

DHL Express

0.33 to 0,5 mm

DHL uses the EAN 128 SSCC (serial shipping container code) as license plate. The DHL size requirements differs a little from the GS 1 size range. This is the reason for this separate size selection. The REA PC-Scan software allows in this section still all Application Identifiers and makes not a restriction to the SSCC only.

4.8.3.1.2 Size specification for ITF 14 codes (ITF 14 SIZE)

For the ITF 14 code, the GS1 Specification was recently adapted to the specifications of EAN 128 with regard to the size. The three setting possibilities "All sizes, 0.25-1.016", General Distribution (0.495 – 1.016 mm) and internal use (0.25 to 0.495 mm) therefore also apply for the ITF 14 code). The background and the size ranges are identical to the EAN 128 specifications.

The older maximum size of 1.2 mm is no longer allowed (apart from transitional regulations).

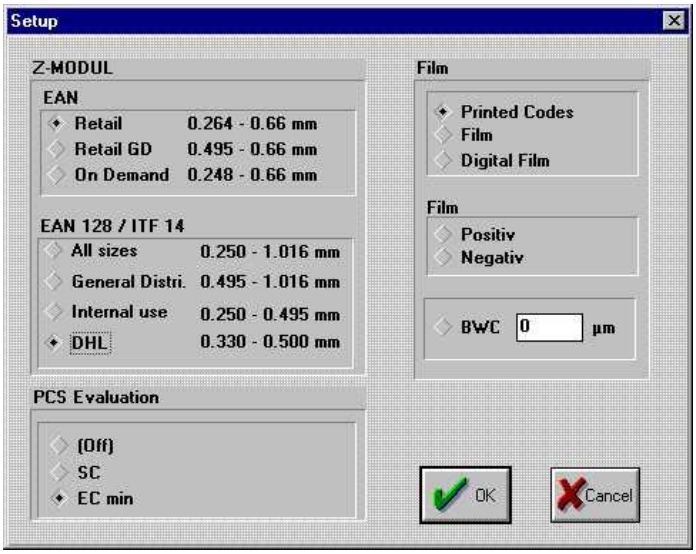
4.8.3.1.3 PCS

The PCS value is the only contrast value of the traditional evaluation. This setting is used to determine whether the PCS will be used or not. If the PCS is used, one of two settings can be selected. The setting PCS (SC) uses the reflectance values R_{min} and R_{max} for the calculation of the PCS value. The difference between R_{max} and R_{min} gives the symbol contrast (SC). The setting PCS (EC_{min}) uses for the calculation of the PCS value the reflectance values R_s and R_b. The difference between R_s and R_b gives the minimum edge contrast (EC_{min}). If the PCS value is not to be used, the setting PCS OFF is selected. The relevant selected PCS value appears on the screen. If the PCS is not displayed the PCS evaluation is switched off. Both PCS variants are always shown on the printed report. Depending on the setting, the deactivated variants are marked in the printed report by means of square brackets, e.g. [PCS(EC_{min}) 0.65 min 0.75]. The relevant deactivated PCS value, or both PCS values (with PCS OFF) do not affect the result of the traditional evaluation. The setting is made simply by clicking the required variant.

Detailed information on the PCS value is given in section 7.2.1.1 .

4.8.3.1.4 Film measurement

This area is used to make the basic initial setting between the measurement of film masters and printed codes.



The setting "Film" enables the measurement of films according to ISO/IEC 15421. The setting "Digital Film" has slightly more generous tolerances than the setting "Film". The setting can be used for larger codes such as EAN 13 or EAN 8 codes from an enlargement factor of 100 %. "Digital Film" is a definition based only on the ISO/IEC 15421 standard. If the standard is to be strictly applied, the setting "Digital Film" should never be used.

Selection can be made between the measurement of positive films or negative films. The definition "Positive film" refers to black bars on a transparent background. The definition "Negative film" refers to transparent bars on a black background. In practice, the definitions of "Positive film" and "Negative film" may be reversed. Nevertheless, the correct setting according to this description must always be made.

An important parameter in conventional printing technology is the print gain. As a rule of thumb, and depending on the printing process, the print gain may be approx. 30 µm for offset printing, approx. 50 µm for gravure printing, and approx. 100 µm for flexo- and relief printing. If working in reverse, i.e. by printing the light spaces onto a dark carrier material, the print gain produces a reduction in the width of the bars. In this case, a bar width increase (BWI) is made in advance in order to compensate for the negative effects of the print gain on the bar width. In the normal case, the bars become wider due to the print gain. This is compensated in the prepress stage by the bar width reduction (BWR). The information to compensate for the print gain is entered in the field BWC in micrometers (µm). A negative BWC value requires narrower bars than the nominal bar width in the prepress stage to compensate for the print gain. A positive value requires wider bars than the nominal bar width in the prepress stage to compensate for the reduction in bar width during printing (1 metre = 1000 mm, 1 mm = 1000 µm, 1 µm = 0.001 mm, 10 µm = 0.01 mm and 100 µm = 0.1 mm).

With increasing print gain and smaller codes, the accurate setting of the bar width reduction becomes increasingly important.

The classical terms BWI and BWR have been replaced by the general designation BWC (bar width correction). If a bar width reduction (BWR) is necessary, the BWC is entered as a negative value with the "–" sign. In the reverse case of a BWI (bar width increase) the figure is entered as a positive value (with + sign or without any prefix).

The preset BWC value will always be shown on the verification report for comparison purposes.

Attention:
Film calibration must first be carried out before the first film measurement is made (see section 4.8.3.1.5). This calibration must be performed separately for positive and negative, and repeated after any change of the substrate. Only very smooth, white paper should be used as the substrate (photographic paper or similar). Normal typewriter paper is unsuitable for this purpose, and leads to measurement inaccuracies.

The function Film measurement is closed by switching to "Printed codes".

A measurement of films or comparably accurate proofs with the setting "Printed codes" will produce *nonsensical* or *misleading* results.

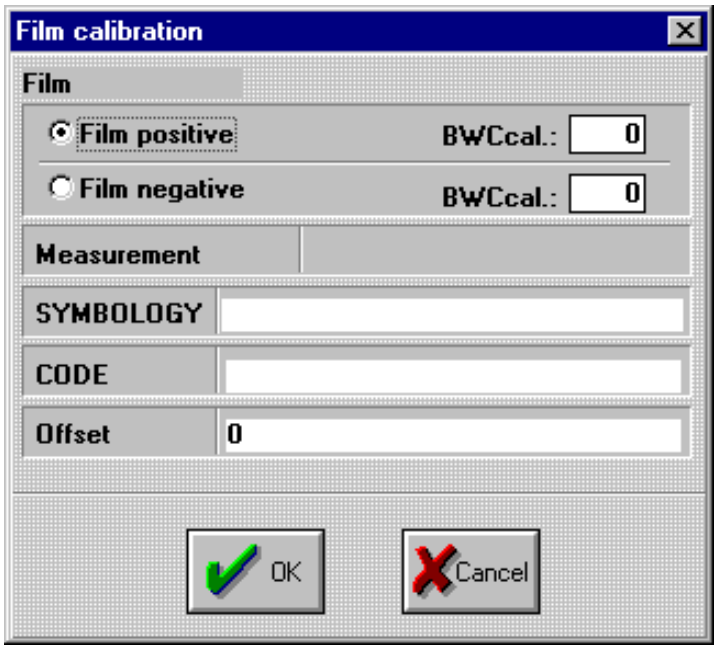
4.8.3.1.5 Film calibration

Before a film can be measured, the laser device must always be calibrated on a white substrate. A white paper or card with the smoothest and most matt surface possible, e.g. photographic paper, should be used as the substrate beneath the film being measured. Substrates with a rough texture, such as typewriter paper, will lead to measurement errors.

Separate calibration must be performed for positive and negative films.

The two optionally available master films are intended to be used for this calibration. For the measurements, the laser device must be used with the film pressure plate (small slot). It is very important that the film lies completely flat during the measurement, since any air under the film will lead to measurement errors.

Usually the master film must be smoothed down by hand onto the substrate, so that the master film "sticks" to the substrate with the aid of static electricity. Cotton gloves are helpful in this case, since they help to produce static electricity, and prevent fingerprints, scratches and other dirt getting onto the calibration films.



The corresponding film type must be selected for the calibration measurement (Film positive or Film negative). The calibration films may show minor variations. These are noted on the parchment paper bags in which the film is supplied. These values must be entered into the relevant field BWCcal. The REA PC-Scan laser device is then placed on the film, and a measurement carried out by pressing the "Scan" button on the laser device. Performing a measurement with the spacebar or with the mouse in the Measure menu is not allowed at this point. After the film has been smoothed down again, the calibration measurement is repeated 2 more times, until a total of 3 measurements have been carried out. The REA PC-Scan software determines from the measurement values a correction value, which compensates for any remaining inaccuracies caused by the substrate used. The correction value is displayed for information purposes in the "Offset" field.

The film calibration is ended by clicking OK, and the following film measurements are then corrected by the calculated values.

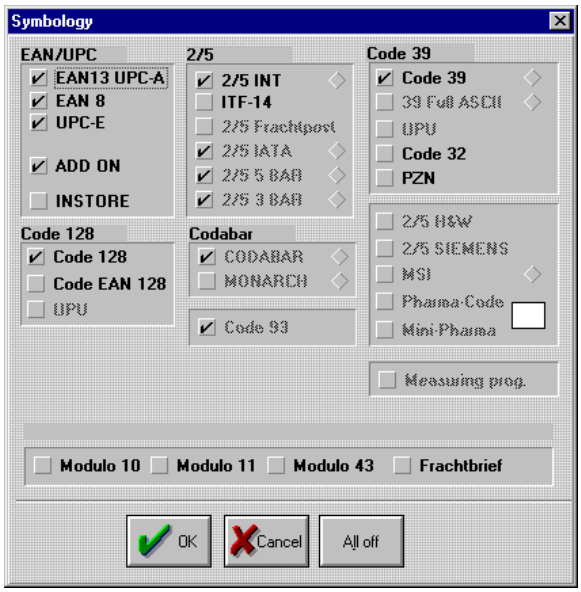
The film calibration is only valid for the substrate used. As soon as another substrate is used, the calibration must be repeated. Dirty, scratched or otherwise damaged substrates must be replaced by new substrates. In this case, the calibration process must also be repeated.

Measurements of production films must always be made on the calibrated substrate.

4.8.3.2 Symbology selection

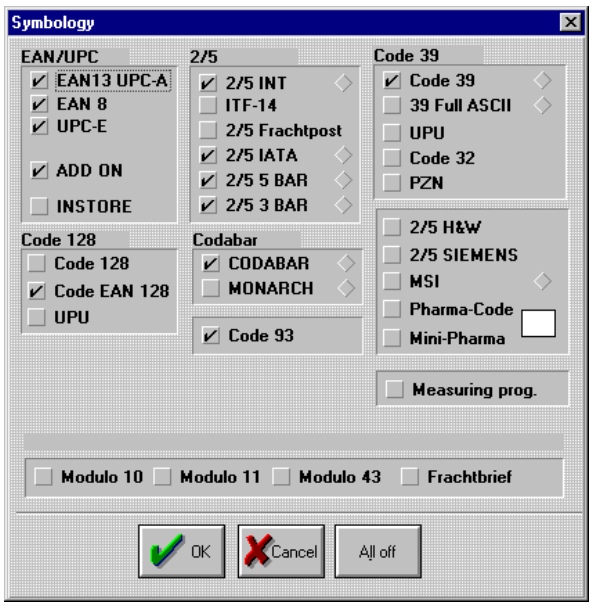
In this dialogue window, the user determines which symbologies are to be measured, and whether multiple symbologies will be distinguished automatically, or whether only a certain symbology is to be measured.

The REA PC-Scan software is available in two different versions. The version without optional Symbologies (also referred to as "PC-Scan SMALL") shows the following dialogue:



The standard codes are shown in black, and can be used. The codes shown in grey are optional, and are not available in this version.

The version including optional symbologies (also referred to as the "full" version) shows the following dialogue:



The previously unavailable codes are now available.

With the button "All off", or if switched off the button shows "All on", the user can switch between the settings symbologies – self-searching and - individual code specified.
In the setting "self-searching" (button shows "All off" since clicking "All off" switches to individual code) multiple symbologies can be activated in any required combination. One exception is the Pharma-Code. The Pharma-Code can only be activated as an individual code. Self-searching is useful when the symbology to be measured is not known, or when continually different symbologies are to be measured.

In the setting "individual code" (button shows "All on", since clicking "All on" switches to self-searching) only one symbology can be activated. This selection is always advisable in the case of poorly or badly printed barcodes. In the case of a very small quiet zone for example, it may be necessary to select this symbology specially, in order to obtain a successful reading. In the case of measurement of codes with very large character spaces, it is also often necessary to select only this symbology, since the large character spaces are often not decoded with the symbology "self-searching".
The measurement program can only be activated in the setting "individual code". No decoding is performed. No multiple measurement is possible with this measurement program. The measurement program shows a reflectance profile over the complete measurement path as result, and creates a table showing the bar and space widths, together with the corresponding reflectance values. The measurement program therefore becomes a powerful aid in the analysis of unknown or partially corrupt codes.

The following symbologies are only available in the setting "individual code":

2/5 H&W
2/5 Siemens
MSI
Pharma-Code
Mini-Pharma

The measurement program is also only available in the setting "individual code".

Further information on the symbologies can be found in the standards and specifications listed in the bibliography in chapter 9.

All codes are briefly described by means of the printed verification report in section 5.2.

In the dialogue window, various areas are designated by a heading, e.g. Code 128 or EAN/UPC. This heading assigns the codes in the field below to this code family. Depending on the definition, codes can only be activated on an either/or or combined basis. If within a family code variants can without exception be distinguished from one another, then it is possible to activate these variants together. If this is not possible (e.g. 2/5i - ITF 14 – Frachtpost or Code 39 – PZN – Code 32) only one or the other variant can be activated within a code family.

With Code 128 and EAN 128, the difference is defined only by the code content. Both are basically a Code 128. EAN 128 is designated by the character FNC1 immediately following the start character. For this reason, both are accepted without any error message in the setting Code 128 error message.

In the setting EAN 128, only EAN 128 is accepted. If a Code 128 is being measured, an error message will be generated. In later versions, the logic will probably be changed. An individual setting will be possible, as well as a collective setting. The individual setting will only accept Code 128 or EAN 128 respectively without an error message. In the collective setting, both are activated and accepted without an error message. The Code 128 UPU cannot reliably be distinguished from the Code 128. Code 128 UPU must therefore be activated individually within the Code 128 family.

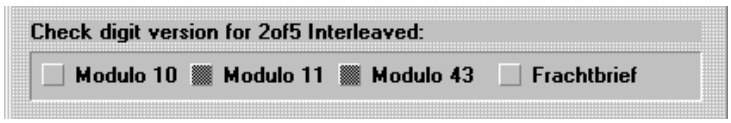
4.8.3.2.1 Symbology selection - Check digit verification

Next to some symbologies, a rhomboid is displayed, which is the switch to enable or disable check digit verification symbology.

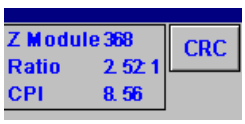
Check digit off

Check digit on

After clicking the rhomboid, the corresponding check digit version (modulo) must be selected in the bar below.



Only those versions can be switched on which are allowed for the relevant symbology. After selecting the version, a black dot appears in the rhomboid If the user needs to check which version is activated, the corresponding box next to the symbology must be clicked. The activated version will then be displayed. The verification is switched off by clicking the bar containing the check digits.
If the check digit verification has not been switched on for a particular symbology, this will be displayed on the monitor after the measurement by a pictogram with the text "CRC". The pictogram appears at the bottom right of the monitor, next to the traditional evaluation.



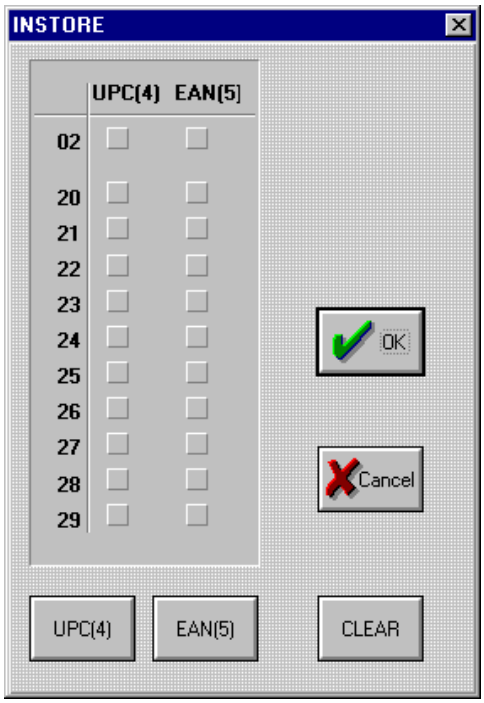
The printed report gives in this case the message "No check digit verification".
If the check digit is incorrect the REA PC-Scan gives an error message shown in the error message window. Additionally the check digit in code content below the histogram is shown in red color.

Some barcode symbologies, such as EAN/UPC, Code 128, ITF 14, 2/5i, Frachtpost, PZN etc., have fixed specified check digits. Switching the check digit verification on and off is not possible for these symbologies. The rhomboid in the symbology selection is not displayed.

4.8.3.2.2 Symbology selection - EAN/UPC Instore codes

The Instore setting refers exclusively to the EAN 13 and UPC-A code. These codes have a special application, which is referred to as INSTORE. The relevant specifications can be found in the GS1 General Specifications, or in the national GS1 manuals based on these specifications. By definition, instore codes are only valid within a store, or at best within a chain of stores. An instore code is clearly identified by the number 2 at the first position from left. This also applies to the 12-digit UPC-A code and the EAN 8 code. Only if the UPC-A code is decoded as an EAN code does it appear as a 13-digit code. UPC-A instore codes are then clearly identified by the first two digits "02" from the left. The REA PC-Scan decodes UPC-A codes always with 13 characters. EAN 8 codes in the instore variant are not affected by this setting.

In difference to normal EAN codes, a second check digit can be verified for instore codes. If the field Instore is clicked with the mouse in the symbology selection, the following dialogue window appears. The list allows selection of the possible instore variants for which the second check digit will also be verified.



If no checkbox is checked for a prefix, the verification of the second check digit is switched off. If a tick is placed in the UPC column, a 4-digit price or weight field will be expected in the right code-half (to the left of the symbol check digit). If the tick is placed in the EAN column, a 5-digit price or weight field will be expected in the right code-half. The 2nd check digit will be calculated from this 4- or 5-digit field, and inserted in about the middle of the code to the left of the price or weight field.
The button UPC(4) activates this variant for all prefixes. This also applies for the button EAN(5). The CLEAR button deletes all instore settings.

The instore composition is as follows:

EAN	P	P	N	N	N	N	P2	PG	PG	PG	PG	PG	CD
UPC	P	P	N	N	N	N	N	P2	PG	PG	PG	PG	CD
OFF	P	P	N	N	N	N	N	N	N	N	N	N	CD

P - Prefix (see above list)
N - Article number
P2 - 2nd check digit
PG - Price or weight
CD - Symbol check digit

Every individual letter or double letter always stands for exactly 1 digit in the code.

Different countries lay down different specifications for the use of such instore codes. For this reason, and depending on the country and application, the relevant correct setting must be made here. Due to the variability in the use of the 2nd check digit, the required mode must be clearly specified, especially in the case of merchandising carried out by a supplier.

Note: Due to the specification of the EAN and UPC codes, the setting for the prefix 02 is always a UPC-A code. The prefixes 20 to 29 are always EAN 13 codes.

4.8.4 Order number

After selecting the sub-menu "Order number" any required number or text can be entered here. This entry is displayed on the monitor and included in the verification report when a measurement is saved. Whether this entry will also be printed out on the report is determined under "Print" (section 4.8.5.2). The order number can be used for any required purposes. The maximum length is 60 numbers or letters, in any combination.

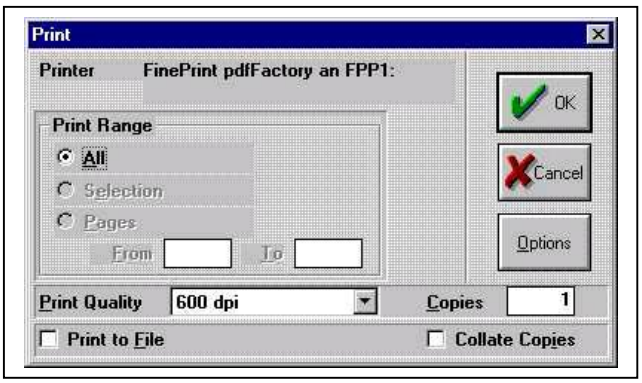
In the installation directory of the REA PC-Scan software, the user or the software can create a file with the name ORDER.TXT. If this file exists, the contents of this file will always be read in as the order number. Manually entered order numbers will be overwritten. Together with the reporting facilities in a CSV file (see section 4.8.7.17), a new order number can be created for each verification report with the aid of a special program. The program monitors the CSV file. As soon as the last allocated order number appears in the CSV file, the program knows that a new measurement has been performed. The program then writes a new order number into the ORDER.TXT file, which is read in by the REA PC-Scan program on initiating the next measurement, and then added to the report.

The "program" for the automatic processing of the order number is not included with REA PC-Scan. This must be created on request and according to the individual EDP environment.

4.8.5 Print

This menu item includes the sub-items "Print", "Setup printer" and "Print options".
"Print" is only required for initiating report printing in case of operation via the keyboard or with the mouse. If using a mouse, the report printout can also be initiated by clicking the printer symbol (see section 4.8.9). The report printout can also be initiated by pressing the print button on the REA PC-Scan laser device.

4.8.5.1 Setup printer



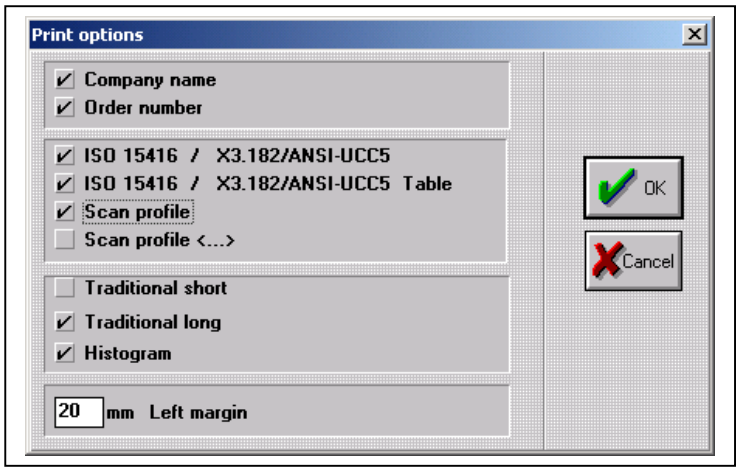
This menu displays the connected printer type and the selected port (e.g. LPT1, LPT2 or network port). The "Print quality" can also be set here, if this facility is offered by the relevant printer type. The number of reports to be printed on a measurement is entered under "Copies".

If the Options button is clicked, the printer selection appears, together with further options for setting the print properties. If for example reports are to be output to two different printers, or if verification reports are to be generated in PDF format (for display in ADOBE Acrobat Reader), then the relevant printer or PDF Writer must be selected here.

PDF Writers are available from several software suppliers. A PDF Writer is not included with the REA PC-Scan software.

4.8.5.2 Print options for report printout

This sub-menu is used for defining the contents and extent of the verification report. When a tick is placed in the checkbox in front of the designation, the relevant reporting option is then activated.



The setting shown in the illustration is the normal standard setting.

Company name
The company name is entered under Options (see under "Options" section 4.8.7.12.). The company name appears at the top of every report page.

Order number
The order number appears on the report. It should be noted that if the order number is deactivated here, it will also not be displayed on the screen view (see section 4.8.4).

ISO 15416/X3.182-ANSI UCC5
If this option is deactivated, the complete ISO 15416/X3.182-ANSI UCC5 evaluation will be omitted from the report. In the normal case, this should always be activated. If master films are being measured, the ISO 15416/X3.182-ANSI UCC5 evaluation cannot be activated, because the measurement results are in this case nonsensical and misleading (see also section 4.8.7.3).

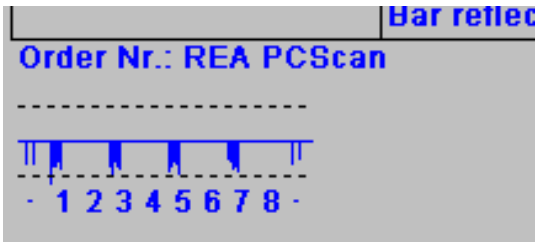
ISO 15416/X3.182-ANSI UCC5 Table
This setting is only relevant if printed codes are being measured, and if multiple measurement is activated. In this case, a final result will only be produced after the preset number of measurements (2 to 10). The basic individual measurements can be seen in the ISO 15416/X3.182-ANSI UCC5 table. The table printout can be switched on or off here (see also section 4.8.7.2).

Reflectance profile
This defines whether the graphic with the reflectance profile will be printed out or not.

Reflectance profile <...>
A section of a reflectance profile, e.g. an enlargement, will be printed out. This is always the reflectance profile section displayed on the monitor. This function is useful for the measurement program if a relevant section is to be displayed, or if for a normal code measurement a particular area needs to be documented.

Traditional short
Traditional long
These two settings can only be activated alternately or switched off completely. If both are deactivated, the complete traditional evaluation will be omitted from the report. If Traditional short is activated, the complete traditional evaluation will be shown, apart from the table "Traditional detailed evaluation". If Traditional long is activated, the complete traditional evaluation and the table with the traditional detailed evaluation will always be printed out.

Histogram
The histogram is a small graphic which displays deviations of bars widths in the form of vertical lines. A vertical line upward means that the relevant bar has been printed too thick. A vertical line downward means that the relevant bar has been printed too thin. The two horizontal dotted lines show the maximum permissible tolerance. The central horizontal line shows the ideal size if there is no variation. The histogram is scaled. Depending on the tolerance values, a certain length of a vertical line will be based on another defined absolute variation.



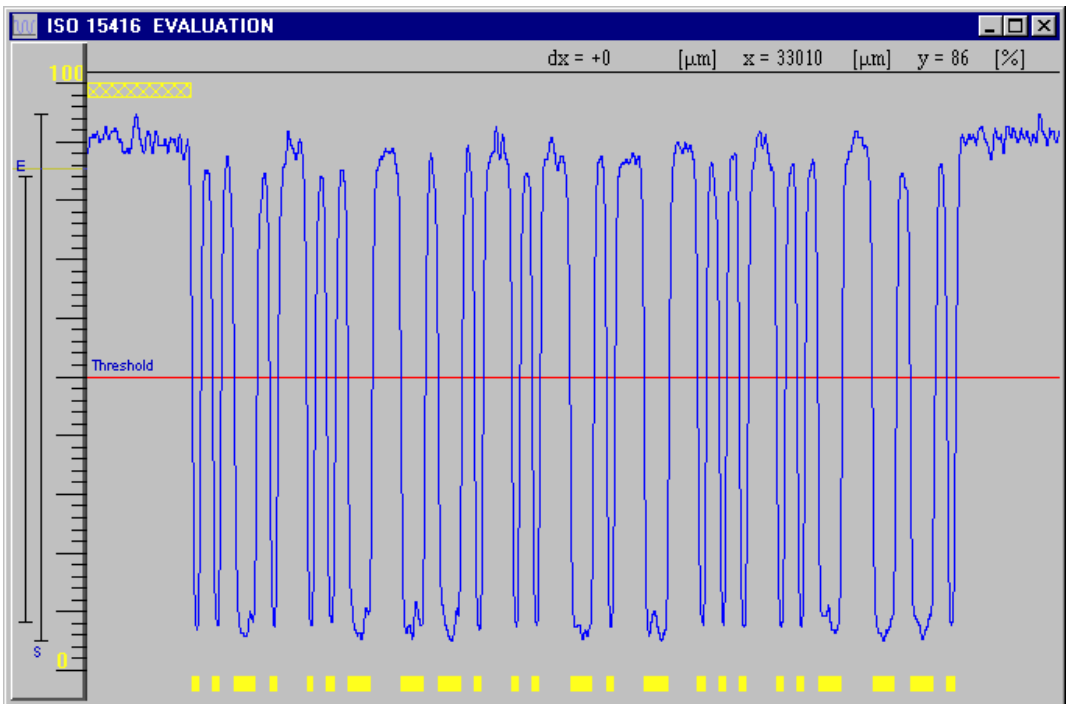
Left margin
This determines the width of the left margin on the report printout. In the normal case, this should not be less than 20 mm.

The printout itself is initiated by clicking pictogram 5 = printer or by pressing the "Print" button on the REA PC-Scan laser device.

4.8.6 Graphics

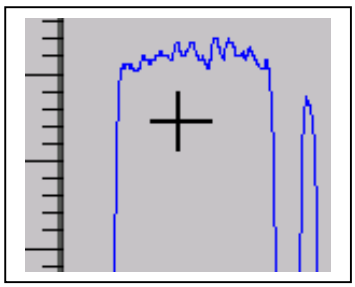
The sub-items listed under this menu item - "Display reflectance profile", "Enlarge", "Reduce" and "Original size" - can be initiated by mouse or by the keyboard. The graphic with the reflectance profile can be enlarged or reduced with Icons 3 and 4 respectively. Icon 7 enables the subsequent display of the reflectance profile, provided that the display for multiple measurement has been deactivated (see section 4.8.7.1). The description of the icons is given in section 4.8.7.1. Icon 7 only appears if a multiple measurement is active and if the display of the reflectance profile has been deactivated.

Original size restores the display in the window to the complete reflectance profile.

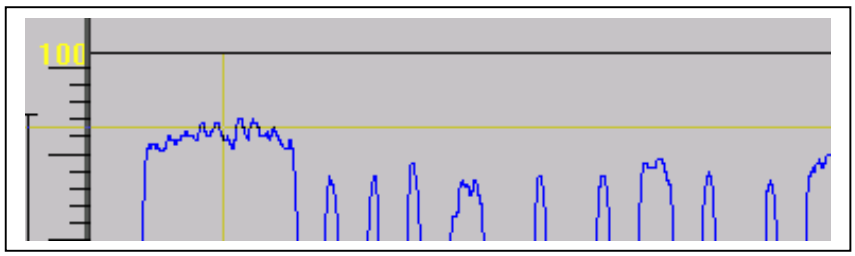


4.8.6.1 Cross

The position cross can be moved with the aid of the mouse to select positions within the reflectance profile in order to make individual measurements.



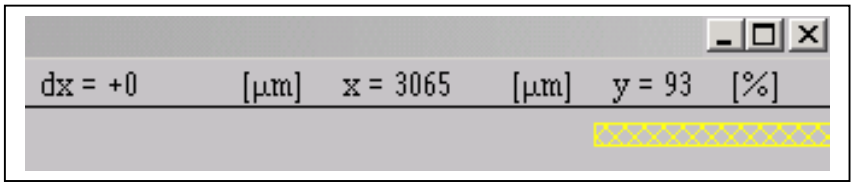
Cross switched off
(position cross only)



Cross switched on
(position cross and yellow crosshairs)

If "Cross" is activated, yellow crosshairs are also displayed on the monitor, which can be used to view every point on the x- and y-axis, in order to examine a profile in detail.

The measurement values at the position of the cross are displayed with the reflectance profile at the top right of the CEN evaluation window.



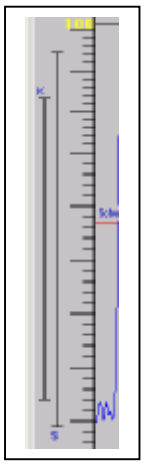
The value dx shows a relative length in µm (microns). For this purpose, any position in the reflectance profile is marked by clicking with the mouse. If the mouse is then moved, dx shows the distance in relation to this selected position. In all cases, only the horizontal x-axis distance is taken into account (differences in height are in this view the reflectance values).

The value x always shows the absolute position of the cross in relation to the beginning of the left quiet zone. Here too, only the x-axis distance is taken into account.

The value y shows the reflectance value measured at the relevant cross position (in the vertical, or y-axis).

Individual measurements can be carried out with the crosshairs and the display of the measurement values at the relevant position of the crosshairs.

4.8.6.2 Graphic display of contrast values



As an aid, the graphic displays the value of the minimum edge contrast (K line) and the value of the symbol contrast (S line) as a vertical line at the left of the graphic.

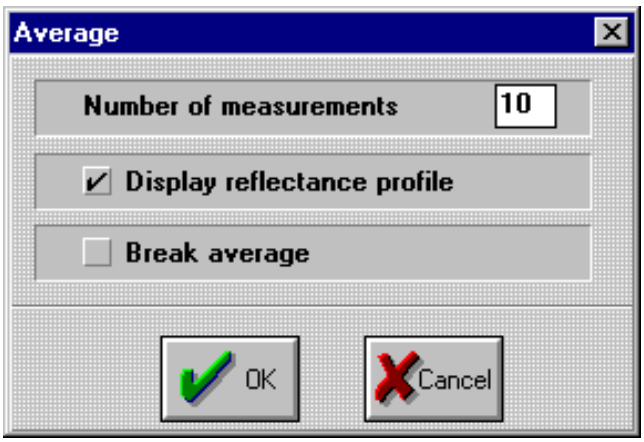
The description of the parameters "Symbol contrast" and "Minimum edge contrast" can be found in section 7.1.

4.8.7 Options

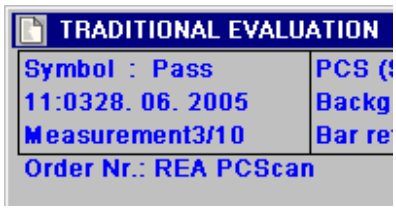
Options offers a range of setting possibilities. Some of these refer to the measurements. The description is arranged so that the operation is described briefly at this point. The background information has been restricted to the minimum essential. More detailed information on the measurement results can be found in chapter 7.

4.8.7.1 Multiple measurement

This sub-menu is used to set the number of multiple measurements, if an average value is to be established from several barcode measurements.



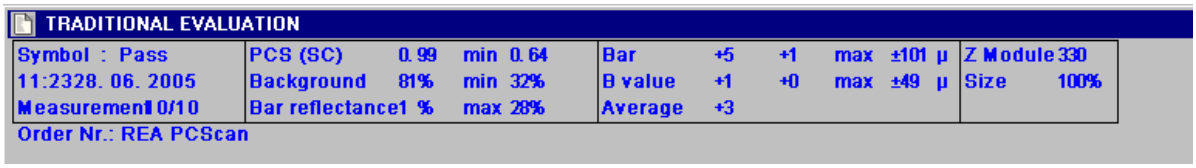
The evaluation for every individual measurement is displayed on the monitor. The number of readings and the set number are displayed at the bottom left of the monitor below the date, e.g. Measurement 3/10 = 3rd measurement of 10.



On completion of the multiple measurement, 10/10 will be displayed here, and the acoustic completion signal will sound.

In order to increase the measurement speed, this sub-menu offers the facility of switching off the display of the reflectance profile for the individual measurements. In order to do this, the tick against the option "Display reflectance profile" must be removed by clicking with the mouse. Irrespective of this, the reflectance profile of the last measurement will always be displayed, together with the average values. If the reflectance profile of an individual measurement is still to be displayed, this can be done immediately after the display of the measurement results with the aid of pictogram 7.

In the traditional evaluation, the calculated average values of the individual parameters are also displayed after the last measurement. The traditional evaluation is not specified for the use of the multiple measurement. This represents no problem in the case of number values. Plausible average values can be determined without any problem. In the case of errors which are present or not, such as quiet zone errors, size errors, ratio errors or check digit errors, any of these errors in a measurement basically leads to the traditional evaluation result: error or failure in the final result of a multiple measurement.



Result of the traditional evaluation for a multiple measurement with 10 measurements

In the CEN/ANSI evaluation, for the individual parameters, the quality will be specified as a percentage, and as a grade from 4 to 0, or A-F. The grades are allocated to certain ranges of percentage values (e.g. symbol contrast of 40 % to 55 % is grade 3, or B). In the multiple measurement, an average value will then be calculated from the results of the individual measurements (scan reflectance profile grade). The average value is the arithmetical average of the individual scan reflectance profile grades. The result is designated as the overall symbol grade. The average values of the individual verification parameters are provided for information only. These average values do not however lead to the final result of a multiple measurement.

Result of the CEN/ANSI evaluation (multiple measurement)

Following the last measurement of a multiple measurement, the percentage is no longer displayed for the individual parameters, but instead the average value from all measurements, and for "Calculated grade" the average of all calculated grades.

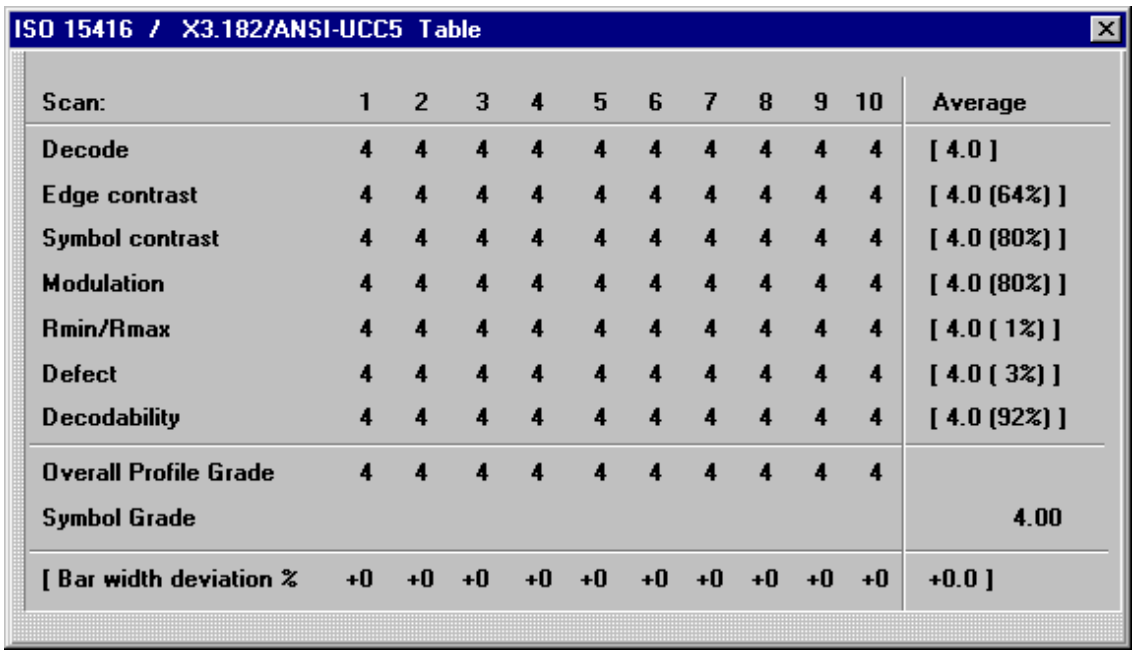
If one or more individual measurements within a multiple measurement are "Not decodable", this measurement will also be counted. In this case however, 10/10 will not be displayed on completion of the multiple measurement, but for example 8/10 or 9/10. In such a case, these figures will be shown on the monitor in red, and highlighted on the report by being underlined.
If no further measurements are to be carried out after "Not decodable" has been displayed, the multiple measurement can be deleted in the "Multiple measurement" menu. After clicking "OK", the counting begins again from 1. Before clicking "OK" however, the number of measurements can be changed if required.

If the measurement program has been selected in the symbology selection, multiple measurement makes no sense, and therefore cannot be selected.

ATTENTION: If a multiple measurement has been started, but not yet completed, several setting possibilities will not be available. As soon as the multiple measurement has been completed, these settings can again be changed.

4.8.7.2 Multiple measurement - Individual measurements in table form

By clicking pictogram 10, a table with all individual values of the individual measurements and calculated grades will be shown on the monitor. Clicking again will restore the old monitor view. The menu item Options/CEN/ANSI Table is identical in function to pictogram 10.



ISO 15416 / X3.182/ANSI-UCC5 Table

Scan:	1	2	3	4	5	6	7	8	9	10	Average
Decode	4	4	4	4	4	4	4	4	4	4	[4.0]
Edge contrast	4	4	4	4	4	4	4	4	4	4	[4.0 (64%)]
Symbol contrast	4	4	4	4	4	4	4	4	4	4	[4.0 (80%)]
Modulation	4	4	4	4	4	4	4	4	4	4	[4.0 (80%)]
Rmin/Rmax	4	4	4	4	4	4	4	4	4	4	[4.0 (1%)]
Defect	4	4	4	4	4	4	4	4	4	4	[4.0 (3%)]
Decodability	4	4	4	4	4	4	4	4	4	4	[4.0 (92%)]
Overall Profile Grade	4	4	4	4	4	4	4	4	4	4	
Symbol Grade											4.00
[Bar width deviation %	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0	+0.0]

The number of measurements is shown at the top of the table in the "Scan" line. The evaluation of the individual parameters follows under the measurement numbers. At the foot of the table, the individual results of the measurements are displayed in the line "Scan reflectance profile grade". The final result is the "Overall symbol grade" in the line below.

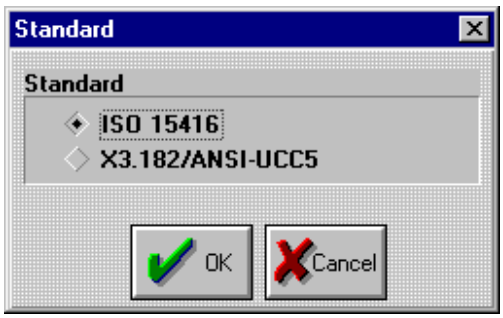
The last information at the foot of the table is the average deviation of all bars within the symbol and the resulting average value. These figures are for information only and do not affect the result of the overall overall symbol grade.

The "Average" column shows the average values of the individual parameters. These average values are for information only and are not used in the final result. These information-only values are therefore shown in square brackets.

Individual, undecoded measurements appear in the table as an empty column.

4.8.7.3 ISO 15416 / X3.182 / ANSI UCC5 switching

This option determines whether the evaluation will be carried out to ISO/IEC 15416 (or the previous standard CEN EN 1635) (setting CEN) or to the ANSI standard ANSI X3.182-1990 or ANSI/UCC5 (setting ANSI).



If measurements are performed using the setting ISO 15416, all symbologies will be included. The setting X3.182/ANSI-UCC5 is divided between the standards ANSI X3.182-1990 and ANSI/UCC5. Standard ANSI X3.182-1990 applies to all symbologies except EAN/UPC. ANSI/UCC5 applies only to EAN/UPC codes.

The REA PC-Scan software makes no distinction between the two ANSI variants, since this produces no changes in the measurement results. The correct basic standard must only be specified for the purposes of quality agreements and for the use of the ANSI standards, depending on the Symbology.

The traditional evaluation is always active for the screen view. The printed report can be configured as required by means of the initial setting.

4.8.7.4 Film calibration

The film calibration is described in section 4.8.3.1.5 together with the preceding chapter on initial settings for film measurement.

4.8.7.5 Aperture

The setting of the measurement aperture and other background information on this subject can be found in section 4.2.

4.8.7.6 Last measurement

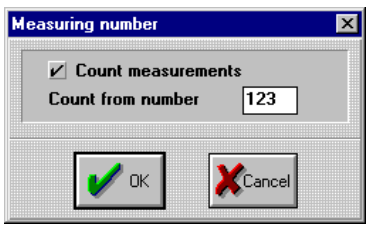
This point corresponds to Icon No. 9. On completion of a multiple measurement, the last individual measurement result can be displayed.

4.8.7.7 Colours

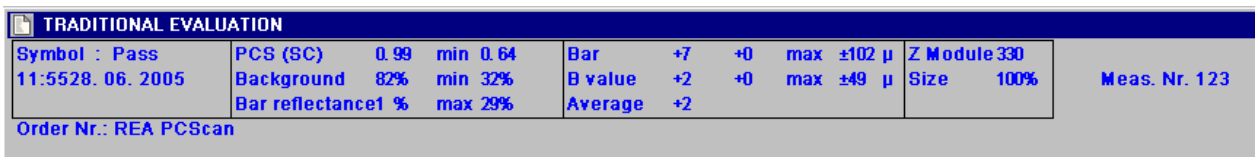
This sub-menu is used to set the colours for the individual areas on the monitor: subset, error designation, reflectance profile, scale etc. In the normal case, these settings should not be changed.

4.8.7.8 Display and print measurement number

This sub-menu is used to switch the display and printout of a measurement number on or off. The starting number from which counting will take place is entered in the field "Count from number". The number entered is the number of the next measurement.



After the measurement, the measurement number will be displayed on the monitor under "traditional evaluation" after any displayed order number.



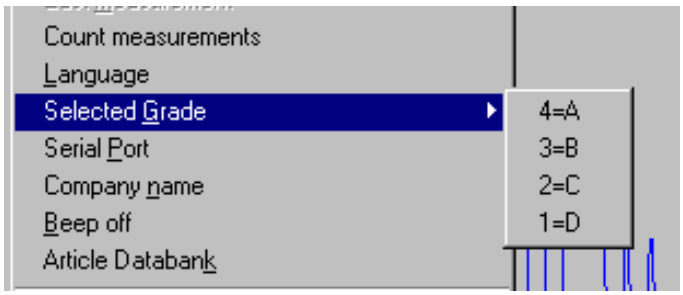
Only successful measurements will be counted. In the case of multiple measurements, a completed multiple measurement will be counted as one measurement.
If the measurement number function is activated, this information will be printed out and saved.

4.8.7.9 Language

This sub-menu is used to select the language to be displayed on the monitor and used on the printed report. At the moment there are four languages available.

4.8.7.10 Select grade

This sub-menu is used to select the quality grade which has been established as the minimum for the corresponding barcode.



During measurement, the calculated grade is compared with the selected grade. If it falls below the selected grade, the result is highlighted in red colour.

When operating the REA PC-Scan with a mouse, the grade can also be changed by directly clicking the field after "Selected grade".

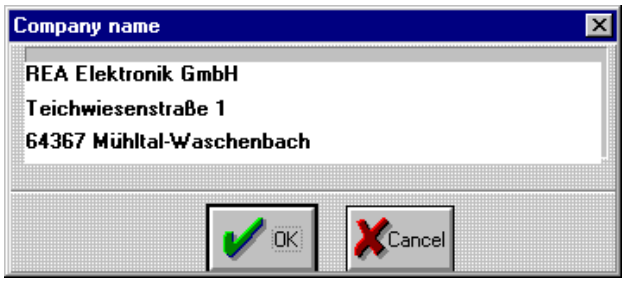
The setting "Selected grade" has no effect on the measurement result. Only the requirement on the measurement result is changed.

4.8.7.11 Serial port

This sub-menu is used to define the free port to which the laser device is to be connected. Further details can be found in section 3.3.

4.8.7.12 Company name

Three lines, each one with 32 characters can be entered in this sub-menu. This company name will be printed on each printed report if the printout has been enabled under "Print"/ "Print options" (see section 4.8.5.2).

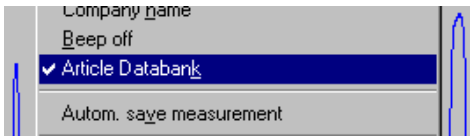


4.8.7.13 Beep off

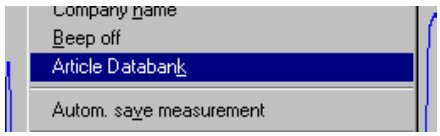
The beeper can be switched off with this menu point. This means that no acoustic signal will be given to indicate successful and/or faulty measurements or the completion of multiple measurements.

4.8.7.14 Article Look Up

This function can only be switched on or off.



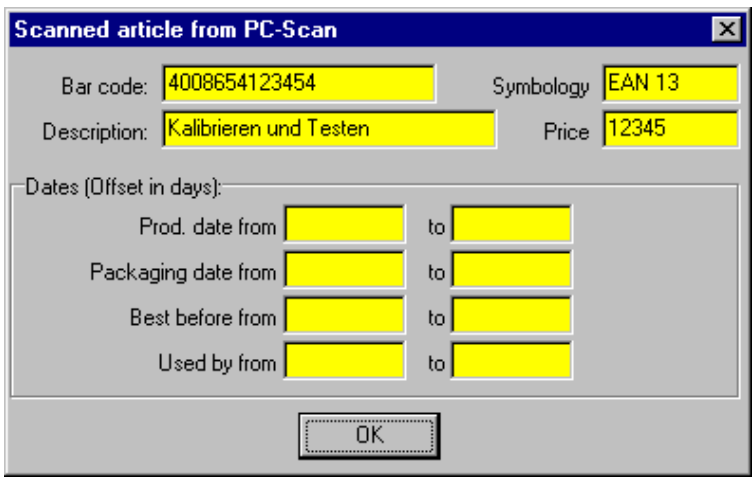
Switched on



Switched off

If this function is switched on, this only has an effect if the REA Article Look Up software is running simultaneously. In this case, the code information with code content will be transmitted to the article database by using a communication mechanism of the operating system. The Article Look Up opens a window and shows an entered article description. This function is always helpful to verify whether the code content is correct, without having to compare it number by number.

The following window appears for a set period of time:



ATTENTION: This function can only be used when working with either Windows NT, Windows 2000 or Windows XP. The database connection does not work under Windows 95, 98 and ME.

4.8.7.15 Automatic measurement storing

If this function is switched on, the verification report will be stored immediately after taking the measurement. The store process makes the operation of the STORE button on the REA PC-Scan laser device superfluous. Apart from that, the function is identical to the STORE button. The description of this function is given in section 4.6.5.

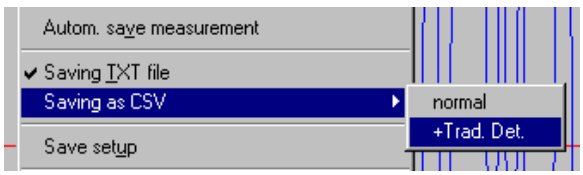
4.8.7.16 Save as text file

The data of a measurement is normally saved in an internal REA PC-Scan format, and not as a text file. Reports saved in this internal format can only be opened with the REA PC-Scan software.

The sub-item "Save as text file" is run from "Options" in the menu bar. If this function is activated, a text file will also be created in addition to the raw data whenever a measurement is stored.
In this case, each file name gets the extension .TXT. The text file can be found and opened by using the chosen file name together with the extension .txt.
The text file contains all information in the same order as a printed report. Exception is the reflectance profile and the histogram graphics. Both is lost because the text format does not allow the embedding of graphics.

4.8.7.17 Save as CSV file

"Save as CSV file" exports the measurement data to a tabular file. The saving takes place automatically as soon as the function is activated. In contrast to the normal storage function, different files are created according to the symbology. If Code 128 codes are being measured, the file CODE128.CSV is created. All Code 128 measurements are stored consecutively in this file. In the case of EAN codes, the corresponding file EAN.CSV is created.



There are two variants. "Normal" provides one line with measurement data per measurement in the table. "+ Trad. Det." is the version which also provides the table with the traditional detailed evaluation. In this variant, 4 lines in the CSV file are used per measurement.

The data provided can be imported for further processing by a spreadsheet, database or statistical software.

In the CSV file, the order number is also saved for each measurement. The order number is specified either manually or by the file "Order.TXT". The allocation of order numbers can be automated with the aid of the file "Order.TXT" (see section 4.8.4).

4.8.7.18 Save parameters

"Save parameters" saves the settings made. These will then be available again on the next program start. The last setting will also be saved on closing the REA PC-Scan program.

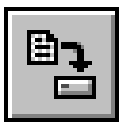
4.8.8 Windows

These settings allow optional arrangement of the windows within the REA PC-Scan program interface. Any rearrangement of the windows will be lost when closing and restarting the REA PC-Scan programme.

4.8.9 Icons

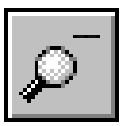
Icons 1-10 can only be used with a mouse, and are used for the quick and easy operation of the REA PC-Scan software.

1 = Open stored measurements by entering or clicking the corresponding file name after the selection window has opened.



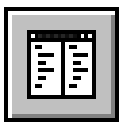
2 = Store a measurement in file with a 8 character long file name.

3 = Zoom into the reflectance profile. Each click enlarges the reflectance profile one stage. An enlarged reflectance profile makes an analysis of the profile at specific positions much easier.
Moving the enlarged reflectance profile is carried out with the aid of the arrow buttons below the reflectance profile.

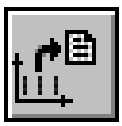


4 = Zoom out of the reflectance profile.

5 = Start the report print out. All information selected under "Print" (see section 4.8.5.2) will be printed out.

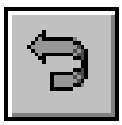


6 = Detailed values: By clicking this Icon a window with the detailed values of the traditional detail evaluation appears on the right side of the monitor. If the Icon is clicked again the window disappears.

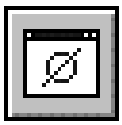


7 = This pictogram is used to call up the subsequent display of the reflectance profile. In the case of multiple measurements, and in order to speed up the display, only the reflectance profile of the last measurement is displayed. In the case of poor or faulty barcodes however, it may be advisable to view this profile. This pictogram is only active in case of multiple measurements and if transfer of reflectance profiles is disabled.

8 = If a bar code fails and no value is highlighted in red to indicate the error then the error message window which opens by clicking this icon should contain an error messagte. These errors will then be displayed on the right half of the monitor, e.g. light margin errors, check digit errors, size errors, ratio errors.



9 = Switch between the last single measurement and the average result after completing a multiple measurement (see section 4.8.7.1).



10 = Display of the ISO/IEC 15416 /X3.183-ANSI UCC5 table. The results of all individual measurements are shown in this table following a multiple measurement (see section 4.8.7.2).

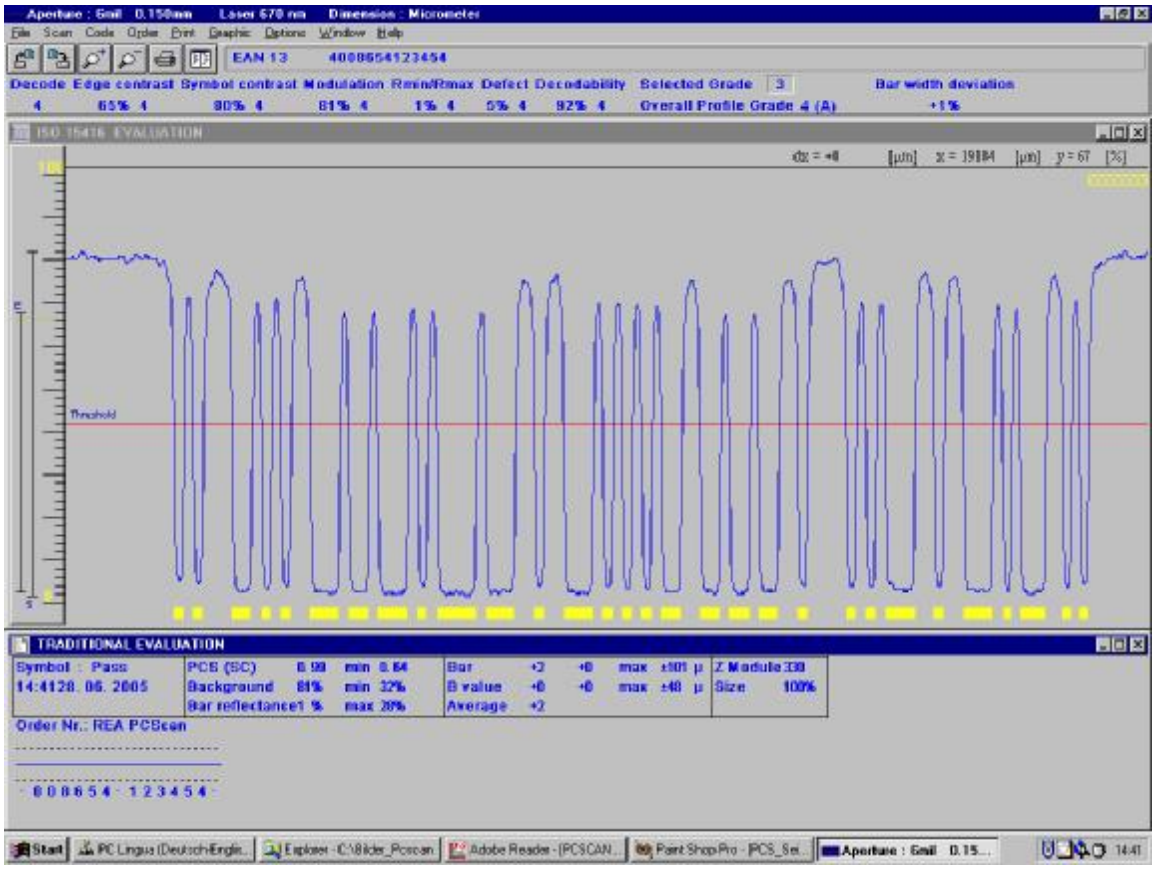
5. Verification report layout

This chapter describes the verification report layout on the screen and the printed report. The chapter gives no detailed description or explanation of the meaning or background of the verification criteria. The aim of the chapter is to enable the assignment and sub-division of the test criteria.

The detailed explanation of the verification method is given in chapter 7.

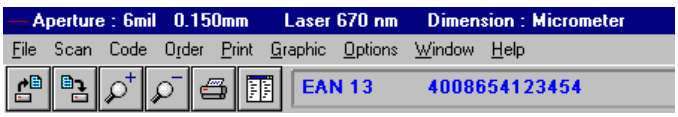
5.1 Results display on the monitor

Following a measurement, the screen display looks as shown in the following illustration:

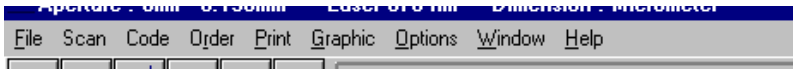


The screen display is divided into areas.

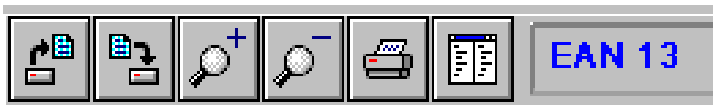
The current aperture is shown in the header line.



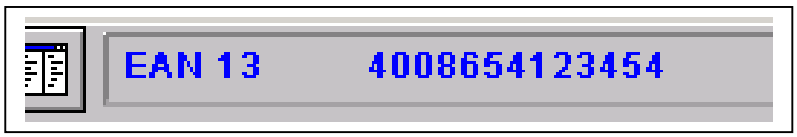
The individual menu points are shown in the menu bar. The description can be found in section 4.8 .



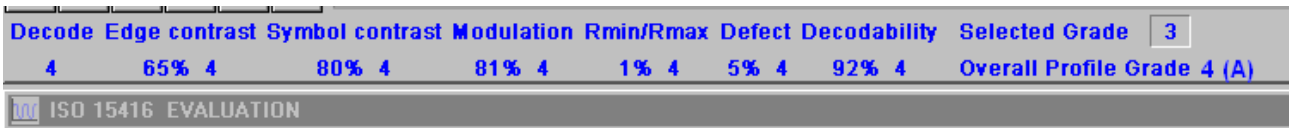
The icons are found under the menu bar. The description is given in section 4.8.9. Some icons are only displayed temporarily, e.g. the stop icon during error messages.



Next to the icon bar appears the information on the barcode symbology (code type) and the decoded code content. If the code content takes up more room than is available in this line, the contents can be shifted with the aid of the mouse cursor. The arrow changes into a hand symbol. If the last character in the line is clicked, the rest of the code content appears. Click on the first character in the line to return to the start of the content.

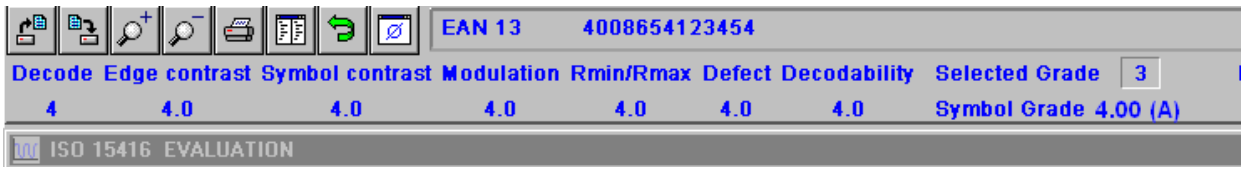


The display of the ISO/IEC 15416 or the ANSI X3.182/UCC5 evaluation comes under the icon bar. In the case of a ISO/IEC 15416 evaluation with an individual measurement, the following view appears:

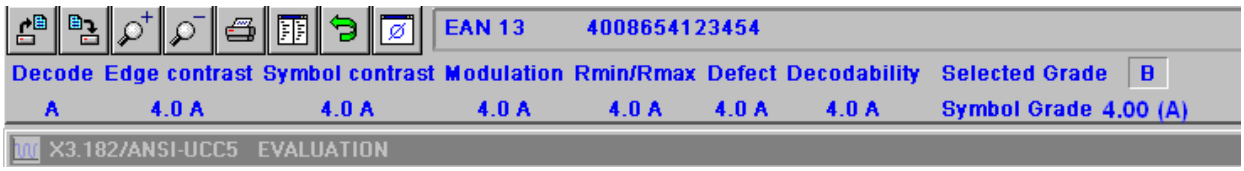


In the case of an ANSI X3.182/UCC5 evaluation with an individual measurement, the following view appears:

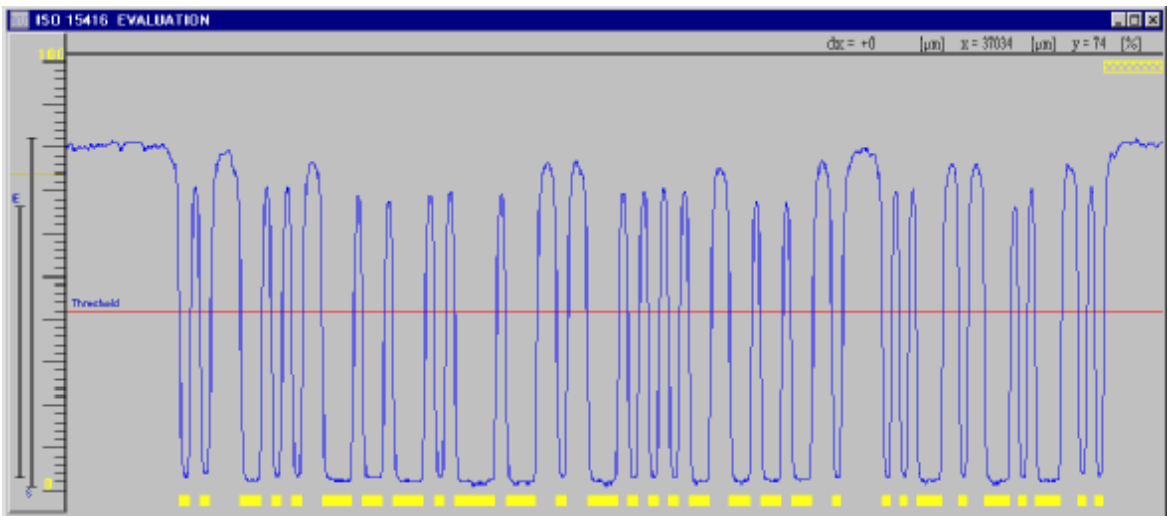
In the case of a multiple measurement, the display of a ISO/IEC 15416 evaluation changes as follows:



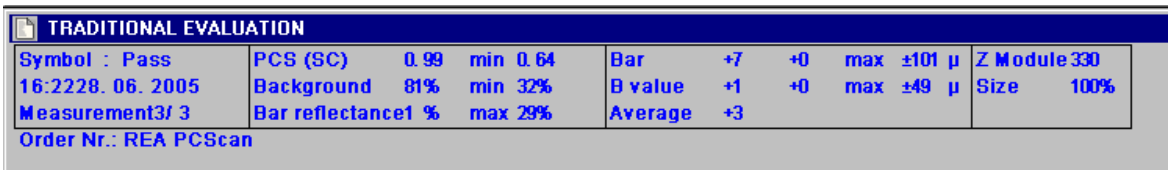
In the case of a multiple measurement, the display of an ANSI X3.182/UCC5 evaluation changes as follows:



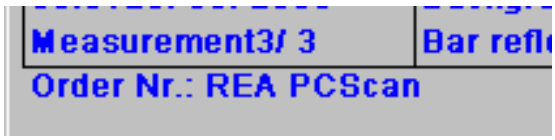
The reflectance profile in the middle of the screen enables a visual assessment of the reflectance characteristics. Details of this are described in section 4.8.6.

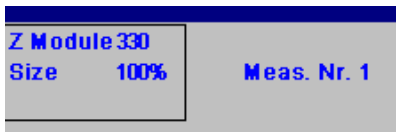


The traditional evaluation is displayed in the lower area of the screen. The time and date of the measurement are also shown in the area of the traditional evaluation.

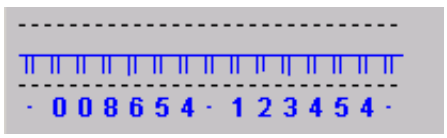


An order number (see section 4.8.4) and a measurement number (see section 4.8.7.8) can be shown below the traditional evaluation, in order to be able to arrange and sort verification reports more easily.

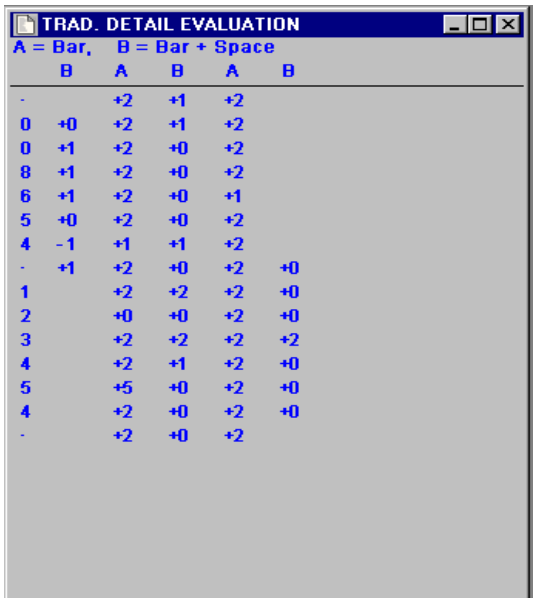




The histogram is displayed right at the bottom of the screen. The histogram is a graphic view of the bar deviations. Vertical lines upward are plus deviations, vertical lines down minus deviations. The longer the vertical lines the greater the deviation from the target value. Vertical lines projecting beyond one of the dotted lines show that the corresponding bar has been printed outside the permissible tolerance.
The vertical lines are arranged below the histogram under the corresponding digits or special characters.
The start, stop and separation codes are shown here as large dots. With e.g. Code 39, a star is used instead of the dots.
All characters that cannot be displayed in the clear text line below the barcode are shown here in two lines, e.g. for Code 128 the function code FNC 1 as F1, the start code C as SC and the stop code as ST.



In addition to the reflectance profile, two further windows can be shown. The window with the traditional detailed evaluation is shown by clicking Icon 6 (see also section 4.8.1). The window with the error messages is shown by clicking Icon 8 or selecting the menu item "Errors" (section 4.8.1).



Window with error messages

Traditional detailed evaluation
The table with the traditional detailed evaluation and the error messages are also printed out. The descriptions of the error messages and the traditional detailed evaluation are given on the following pages.

5.2 The printed verification report

The printed report shows all information displayed on the screen. The configuration as to which parts of the report are to be printed is defined under the Print menu (see section 4.8.5.2). Some parts of the verification report are set in square brackets [text]. The information in square brackets is basically for information only and is not included in the result of the verification.

5.2.1 Report header text

The header text is repeated on each page of the report.

```
REA PC-Scan Ver. 3.23                                  1

REA Elektronik GmbH
Teichwiesenstraße 1
64367 Mühltal-Waschenbach                              2

Aperture   :       8mil 0.200mm                        3
LIGHT TYPE :       Laser 670 nm                        4
Unit :             Micrometer                          5
Order number : Operating instructions                  6

Date  : 27. 08. 2004
Time  : 15:32                                          7

Symbology : EAN 13                                     8
CODE : 4008700248087                                   9
```

1 Specification of the equipment type and software version (here 3.23)
2 Company address (see section 4.8.7.12 and section 4.8.5.2)
3 Aperture setting (here 8 mil, see section 4.8.7.5)
4 Light wavelength, here 670 nm (red light). The wavelength is determined by the built-in laser diode. 670 nm can optional be replaced with 635 nm.
5 Unit of measure for all metric information
6 Order number (see section 4.8.4 and section 4.8.5.2)
7 Date and time of measurement, taken from PC clock
8 Decoded symbology
9 Decoded code content, as also transmitted by a scanner

5.2.1.1 Report section – ISO/IEC 15416 evaluation, individual measurement

```
ISO 15416 EVALUATION                        1

Selected grade 1                            2
Scan reflectance profile grade    4 (A)
       3

Decode                      4               4
Edge contrast              64% 4            5
Symbol contrast            86% 4            6
Modulation                 74% 4            7
Rmin/Rmax                  1% 4             8
Defect                     5% 4             9
Decodability               81% 4           10

Bar deviation              -3%             11
```

1. Heading ISO/IEC 15416 evaluation
2. Selected grade – this is the required minimum quality (see section 4.8.7.10)
3. Measured, or achieved quality grade
4. Decode parameter
5. Minimum edge contrast parameter
6. Symbol contrast parameter
7. Modulation parameter
8. R_{min}/R_{max} parameter
9. Defects parameter
10. Decodability parameter
11. Bar deviation in percent, in relation to the module width (for information only)

All evaluation criteria are described in section 7.1.

5.2.1.2 Report section - ISO/IEC 15416 evaluation, multiple measurement

```
ISO 15416 EVALUATION                                                    1
Selected grade     1                                                    2
Scan reflectance profile grade >3.00 (B)<
       3

CEN/ANSI table                                                          4
Scan:               1    2    3    4    5    Average                  5

Decode              4    4    4    4    4    [ 4.0 ]                  6
Edge contrast       4    4    4    4    4    [ 4.0 (51%) ]            7
Symbol contrast     4    4    4    4    4    [ 4.0 (84%) ]            8
Modulation          3    3    3    3    3    [ 3.0 (60%) ]            9
Rmin/Rmax           4    4    4    4    4    [ 4.0 ( 3%) ]           10
Defect              4    4    4    4    4    [ 4.0 ( 8%) ]           11
Decodability        4    4    4    4    4    [ 4.0 (83%) ]           12

Scan reflectance profile
grade               3    3    3    3    3                            13

Overall symbol grade                          3.00
      14

[ Bar deviation% -9   -9   -9   -9   -9   -9.0 ]                      15
```

1. Heading CEN evaluation
2. Selected grade – this is the required minimum quality (see section 4.8.7.10)
3. Measured, or achieved quality grade
4. Heading ISO/IEC 15416 evaluation, table of multiple measurement
5. Number of measurements performed (between 2 and 10)
6. Decode parameter, one figure per measurement
7. Minimum edge contrast parameter, one figure per measurement
8. Symbol contrast parameter, one figure per measurement
9. modulation parameter
10. R_{min}/R_{max} parameter, one figure per measurement
11. Defects parameter, one figure per measurement
12. Decodability parameter, one figure per measurement
13. Results of the corresponding individual measurements
14. Overall result: average value of scan reflectance profile grades
15. Bar deviation in percent, in relation to the module width (for information only)

All test criteria are described in section 7.1

In lines 6 to 12 an average value is shown at the end of each line in square brackets. These figures are average values for the corresponding parameters. Since these figures are not used directly for calculating the overall symbol grade in line 14, these figures are for information only (and therefore shown in square brackets). In the ANSI 3.182/UCC5 evaluation, the output is in principle identical. The only difference is that the grades are shown in the form of letters.

5.2.1.3 Report section - Traditional evaluation

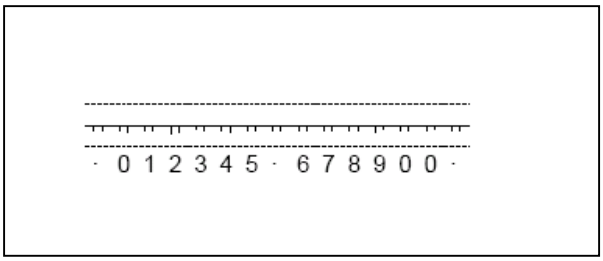
The traditional evaluation is divided into a general section, the histogram and the Traditional detailed evaluation.

The general section shows the PCS value in two variants then follows an overview of the metric evaluation with the barcode size in the last line. The metric evaluation, size specification and traditional detailed evaluation depend on the barcode symbology measured.

```
TRADITIONAL EVALUATION                                  1

Symbol : Pass                                           2

Measurement 5/5                                         3

[ PCS (EC_min)      0. 98 min 0. 75 ]                   4
[ Light value       65% min 32% ]
[ Dark value        1 % max 16% ]

PCS (SC)            0. 99 min 0. 60                     5
Light value         87% min 32%
Dark value          1 % max 34%

Bars +16 - 41       max ±104 µ                          6
B-value +10 - 8     max ±50 µ
Average value - 11

Z-Module 339                                            7
Size 103% SC 2
```

1. Heading - Traditional evaluation
2. Result of the traditional evaluation, result Symbol "Pass" or "Fail"
3. Number of measurements (for multiple measurement only)
4. PCS (EC_{min}) with basic reflectance values (see section 7.2.1.1)
5. PCS (SC) and PCS(EC_{min}) of one other measurement position (see section 7.2.1.1). Both PCS variants can be switched off (see section 4.8.3.1.3). If one PCS value, or both, are switched off, this will be shown by means of square brackets [PCS ...]. Square brackets denote information which has no effect on the measurement result, and is therefore given for information purposes only
6. Metric figures with extreme values and average value. The information in this block depends on the barcode symbology (see section 7.2.1.2)
7. Size specification of the barcode. The Z-module (measured module width, corresponds to the ideal width of a narrow bar) is always given. The other information depends on the barcode symbology (see section 7.2.1.3)

The histogram shows individual bar deviations as vertical lines. The individual vertical lines are allocated to the individual characters of a barcode symbol. Vertical lines downward show that the bars are thinner than the nominal width. Vertical lines upward show that the bars are thicker than the nominal width. The traditional tolerance of the bar widths has been exceeded if the vertical lines project beyond the upper or lower dotted lines. The bars have almost the ideal width if no vertical lines can be seen.



5.2.2 Explanations on the traditional detailed evaluation

This section shows for each barcode symbology the part of the report containing the specific code-type information. This chapter is only an explanation of which values can be found where. In section 7.2.1.4 the measurement values are described in general, without going into detail about the layout of the verification report.
All measurement values in the description are example figures, which in reality may be impossible in this combination.

5.2.2.1 EAN/UPC code family

This family supports the EAN 13, UPC-A, EAN 8, UPC-E, also with 2 or 5 digit add-on and the instore versions. These codes are used at point of sale for the automatic identification of the goods at the supermarket checkout.

In the case of the add-ons, the quiet zone between the main code and the add-on is also measured. The traditional detailed evaluation is explained here using the example of an EAN 13 code.

The EAN 13 code and the related symbologies are measured in "A" and "B" values. The "A" value is a single bar. The "B" value is a bar and the following space.

Specification of Symbology and code contents

```
SYMBOLOGY:      EAN 13
CODE:           4008654123454
```

Symbology is the code type or kind of barcode.
Code is the decoded contents of the measured barcode symbol

Metric information with extreme values and average value

```
Bars            -11   +14   max   ± 101µ
B-value         - 6   + 9   max   ±  49µ
Average value         + 4
```

The two bar values are the extreme values of the bar deviation, as determined from the table - Traditional detailed evaluation (A-columns).
The two B-values are the extreme values of the width of neighbouring bars and spaces together. The B-values are determined from the table - Traditional detailed evaluation (B-columns).
The average value is an average value of all bar deviations. The values of the A-columns from the table - Traditional detailed evaluations are added together, and then divided by the number of bars.
The max values are the maximum allowed tolerances.

Size information

```
Z-module 341
Size 103% SC 2
```

The Z-module is the measured module width. The figures are given in micrometers (µm).
In the case of the EAN code, the size information refers to the size 1 specified in the standard. This corresponds to 100 %. The standard specifies a module width of 330 µm for this size. If the measured Z-module width (here 341 µm) is divided by the module width at size 1 (always 330 µm), and the result multiplied by 100, then this gives the size in percent, the so-called magnification factor.
The information SC 2 (range SC 0 to SC 9) comes from an old DIN standard, in which a SC value is allocated to certain sizes in percent. The SC figure is only used in Germany. The SC sizes can also be found in the specifications of GS1 Germany (formerly CCG) (see section 5.2.2.1.1).

Table - Traditional detailed evaluation

A = bars			B = bars + spaces			
	B	A	B	A	B	
•						Explanation
		+ 4	+1	+ 4		Start character 2 bars one space (*1)
0	+1	+ 4	-1	+ 4		1st effective character, left half of code (*2)
0	+4	+ 4	-1	+ 4		
8	-6	-11	+4	+ 3		
6	-3	+ 1	+9	+ 4		
5	+6	+ 7	+0	+ 6		
4	-6	+ 4	+9	+ 14		
•	-8	+ 4	+4	+ 4	+1	Separating character
1		+ 4	-4	+ 9	-4	1st effective character, right half of code
2		+ 7	+1	+ 4	-2	
3		+ 7	+1	+ 4	+6	
4		+ 0	-8	+ 4	+0	
5		+ 4	-1	+ 6	+3	
4		+ 4	+7	+ 4	-6	
•		+ 4	+5	+ 9		Stop character

If the main code is supplemented by a 2-digit add-on, the following table also appears:

•		-22	-43	-73	left edge character
1	+ 3	- 8	-60	+ 1	1st effective character “1”
•	- 3	-79			Separating character
0	+25	- 1	+17	+20	2nd effective character “0”

The composition of a 5-digit add-on is in principal identical to the 2-digit add-on. The content is simply increased to 5 effective characters with the intervening separating characters.

(*1) The first B-value is in the start character and consists of the space in the start character and the following bar.

(*2) The second B-value is the second space together with the following neighboured bar.

The code illustrated starts with a 4, (the 13th character) this 4 does not appear as a character in the detailed evaluation, since it is a supplementary character produced by a subset change in the left half of the code. The reason for this is compatibility with the American UPC-A symbol (12 characters with a 13th character 0 suppressed within the EAN system), which has no subset change within a code-half, and is therefore clearly distinguishable.

5.2.2.1.1 Tolerance values and module widths for EAN/UPC codes

Factor	SC size	Module width	Permissible tol. ± Bars and spaces	Permissible tol. ± B-value
80 %		264 µ	36 µ	39 µ
82 %	SC 0	270 µ	42 µ	40 µ
85 %		280 µ	52 µ	41 µ
90 %	SC 1	297 µ	68 µ	44 µ
95 %		314 µ	84 µ	46 µ
100 %	SC 2	330 µ	101 µ	49 µ
110 %	SC 3	363 µ	115 µ	53 µ
120 %	SC 4	396 µ	131 µ	58 µ
130 %		429 µ	147 µ	63 µ
135 %	SC 5	445 µ	156 µ	65 µ
140 %		462 µ	162 µ	68 µ
150 %	SC 6	495 µ	178 µ	73 µ
160 %		528 µ	193 µ	78 µ
165 %	SC 7	544 µ	200 µ	80 µ
180 %		594 µ	224 µ	87 µ
185 %	SC 8	610 µ	233 µ	90 µ
200 %	SC 9	660 µ	255 µ	97 µ

5.2.2.2 Code 128 family

Code 128 is a barcode symbology with four different bar widths. It is often used in industrial applications. The special case EAN 128 is designated by a special character at the start of the code (FNC1). Otherwise, EAN 128 does not differ from Code 128, except for some tolerance and size specifications and the defined standardised data structure within the code. Code 128 is a dense, alpha-numeric code, whose character density may even exceed that of 2/5 Interleaved. The variant Code 128 UPU is a variant with defined code contents, specified by the Universal Postal Union, for postal applications. The normal Code 128 and EAN 128 are supplied as standard. Code 128 UPU is optional (part of optional symbologies).

Specification of symbology and code contents

```
SYMBOLOGY:      Code 128
CODE:           ABC
```

Symbology is the barcode type
Code is the decoded contents of the measured barcode symbol

Metric information with extreme values and average value

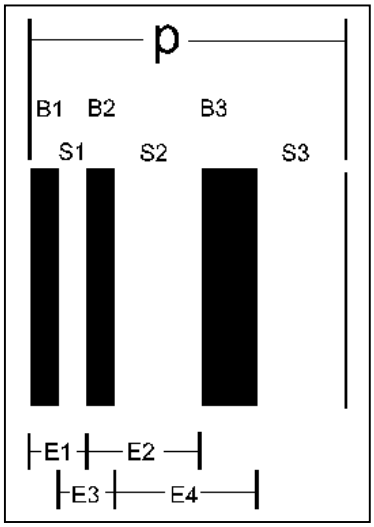
```
Bar         +129  - 16       max ±141 µ
Space       + 50  -114       max ±141 µ
E-value     + 68  - 70       max ± 77 µ
P-value     + 73  - 33       max ± 77 µ
Average value   + 42
```

The two bar values are the extreme values of the bar deviation, determined from the table - Traditional detailed evaluation (1st line B B B).

The two space values are the extreme values of the space deviation, determined from the table - Traditional detailed evaluation (2nd line S S S).

The two E-values are extreme values of the width of neighbouring bars and spaces taken together. The E-values are determined from the table - Traditional detailed evaluation (3rd line E E E E).

The P-value is the overall width of a character (always consisting of 11 modules, except for the stop character), which will later give one, or in subset C, two decoded characters.



The average value is an average value of all bar deviations. The values from the 1st line of the table - Traditional detailed evaluation, are added together and divided by the number of bars.

Size information Code 128 and UPU

```
Z-module 385
CPI 6. 0
```

The specification of the Z-module is in micrometers (µm), identical to the EAN code described above. Since there is no further size definition for Code 128, the character density is also specified in CPI (**C**haracters **P**er **I**nch).

Size information EAN 128

```
Z-module   385
MF         0.385
```

EAN 128 uses an MF (Magnification Factor) as the size specification. This is specified in the GS1 General Specifications. The magnification factor is in fact not an enlargement factor, but merely the Z-module in millimetres. The term MF was chosen with reference to the magnification factor of the EAN/UPC code. If used as Magnification factor then the Magnification factor relates to size 1.

Table - Traditional detailed evaluation

The description of the table - Traditional detailed evaluation is given using the example of a Code 128 using subset B.

Each character is assigned 3 lines. The first line contains the deviations of the 3 bars of the character from the target value (B = bar).

The second line contains the deviations of the three spaces from the target value (S = space). The P gives the deviation of the complete character from the target value. The complete character consists of three bars and three spaces.

The third line contains the E-values (designating the bars and spaces together). The first E-value is the first bar with the following space. The second E-value is the second bar with the following space. The third E-value is the first space with the following (middle or second) bar. The fourth E-value is the second space with the following bar.

The stop character is shown twice, seen once from left to right and once (backwards) in the direction from the end to the start of the character (right to left).

The column with the designation "Value" gives the symbol character value. Depending on which subset (A, B or C) is being used, the symbol character value gives one (Subset A and B) or two (for Subset C) other data characters.
Example: The symbol character value 65 gives in Subset A the control character ‘SOH’, in Subset B the letter ‘a’ and in Subset C the numbers ‘6’ and ‘5’). See also the table below with the complete character set and the interpretations of the symbol character value in the columns for Subset A, B and C.

Example of a Code 128 evaluation with subset B

```
SYMBOLOGY       CODE 128
CODE            ABC

     B          B          B
     S          S          S          P
     E          E          E          E     Value Explanation
SB   + 64       +163       +159             104   start character, start with subset B
     -147       -125       -174       -60
     - 83       + 16       + 38       +34
A    +133       +150       + 81              33
     -135       -101       - 99       +29
     -  2       + 15       + 49       -20
B    +160       +117       +101              34
     -139       -113       -157       -31
     + 21       - 22       +  4       -12
C    +196       +192       + 52              35
     -193       - 95       - 63       +89
     +  3       -  1       + 97       -43
!    + 69       + 24       + 22               1   Check digit
     - 50       - 12       - 67       -14
     + 19       - 26       +  2       +10
ST   + 96       + 64       + 95             106   Stop character
     -100       - 52       - 75       +28
     -  4       - 36       + 12       +43
<-   + 46       + 95       + 64                   Reverse stop character
     - 75       - 52       -100       -22
     + 12       + 43       + 20       -29
```

Example of a Code 128 evaluation with subsets B and C

SYMBOLOGY CODE 128
CODE A5023215006881

	B S E	B S E	B S E	P E	Value	Explanation
SB	-29	- 7	+ 8		104	Start character with subset B
	+18	+ 2	+13	+ 5		
	-11	+11	- 5	+10		
A	-31	-16	-10		33	
	+34	- 2	+30	+ 5		
	+ 3	+18	-18	-12		
5	-48	-49	+ 3		21	
	+53	+17	- 6	-30		
	+ 5	+ 4	-32	+20		
CC	- 2	-64	-44		99	Change to subset C
	+41	+49	+41	+21		
	+39	-23	-15	+ 5		
02	- 7	-13	-20		02	Display of character value
	+ 5	+18	+34	+17		a number pair
	- 2	- 8	+ 5	- 2		
32	-29	- 1	-29		32	
	+ 2	+22	+26	- 9		
	-27	+ 1	+21			
15	-19	-18	-21		15	
	+16	+32	+16	+ 6		
	- 3	- 2	+14	+11		
00	- 5	-26	-13		0	
	- 2	+35	+ 5	- 6		
	- 7	-28	+ 9	+22		
68	+11	+26	-16		68	
	-22	-22	+33	+10		
	-11	+ 4	+ 4	-38		
81	+11	-20	-25		81	
	- 3	+20	+27	+10		
	+ 8	-23	+ 0	- 5		
50	- 4	- 7	-37		50	Check digit
	+ 0	+22	+42	+16		
	- 4	- 7	+15	-15		
ST	-26	-34	- 7		106	Stop character
	+32	+20	+32	+17		
	+ 6	- 2	-14	+13		
<-	-11	- 7	-34			Reverse stop character
	+32	+20	+32	+32		
	-14	+13	+25	+21		

Table with Code 128 subset and conversion from the reference value

Symbol character value	Subset A	Subset B	Subset C	PC-Scan A	PC-Scan B
0	SP	SP	00		
1	!	!	01	!	!
2	“	“	02	“	“
3	#	#	03	#	#
4	$	$	04	$	$
5	%	%	05	%	%
6	&	&	06	&	&
7	‘	‘	07	'	'
8	(	(	08	(	(
9	)	)	09	)	)
10	*	*	10	*	*
11	+	+	11	+	+
12	,	,	12	,	,
13	-	-	13	-	-
14	.	.	14	.	.
15	/	/	15	/	/
16	0	0	16	0	0
17	1	1	17	1	1
18	2	2	18	2	2
19	3	3	19	3	3
20	4	4	20	4	4
21	5	5	21	5	5
22	6	6	22	6	6
23	7	7	23	7	7
24	8	8	24	8	8
25	9	9	25	9	9
26	:	:	26	:	:
27	;	;	27	;	;
28	<	<	28	<	<
29	=	=	29	=	=
30	>	>	30	>	>
31	?	?	31	?	?
32	@	@	32	@	@
33	A	A	33	A	A
34	B	B	34	B	B
35	C	C	35	C	C
36	D	D	36	D	D

Symbol character value	Subset A	Subset B	Subset C	PC-Scan A	PC-Scan B
37	E	E	37	E	E
38	F	F	38	F	F
39	G	G	39	G	G
40	H	H	40	H	H
41	I	I	41	I	I
42	J	J	42	J	J
43	K	K	43	K	K
44	L	L	44	L	L
45	M	M	45	M	M
46	N	N	46	N	N
47	O	O	47	O	O
48	P	P	48	P	P
49	Q	Q	49	Q	Q
50	R	R	50	R	R
51	S	S	51	S	S
52	T	T	52	T	T
53	U	U	53	U	U
54	V	V	54	V	V
55	W	W	55	W	W
56	X	X	56	X	X
57	Y	Y	57	Y	Y
58	Z	Z	58	Z	Z
59	[	[	59	[	[
60	\	\	60	\	\
61	]	]	61	]	]
62	^	^	62	^	^
63	__	__	63	_	_
64	NUL	‘	64	NL	'
65	SOH	a	65	SH	a
66	STX	b	66	SX	b
67	ETX	c	67	EX	c
68	EOT	d	68	ET	d
69	ENQ	e	69	EQ	e
70	ACK	f	70	AK	f
71	BEL	g	71	BL	g
72	BS	h	72	BS	h
73	HT	i	73	HT	i
74	LF	j	74	LF	j
75	VT	k	75	VT	k
76	FF	l	76	FF	l
77	CR	m	77	CR	m
78	SO	n	78	SO	n
79	SI	o	79	SI	o
80	DLE	p	80	DE	p
81	DC1	q	81	D1	q

Symbol character value	Subset A	Subset B	Subset C	PC-Scan A	B
82	DC2	r	82	D2	r
83	DC3	s	83	D3	s
84	DC4	t	84	D4	t
85	NAK	u	85	NK	u
86	SYN	v	86	SY	v
87	ETB	w	87	EB	w
88	CAN	x	88	CN	x
89	EM	y	89	EM	y
90	SUB	z	90	SB	z
91	ESC	{	91	ES	{
92	FS	|	92	FS	|
93	GS	}	93	GS	}
94	RS	~	94	RS	~
95	US	DEL	95	US	DL
96	FNC 3	FNC 3	96	F3	F3
97	FNC 2	FNC 2	97	F2	F2
98	SHIFT	SHIFT	98	SH	SH
99	CODE C	CODE C	99	CC	CC
100	CODE B	FNC 4	CODE B	CB	F4
101	FNC 4	CODE A	CODE A	F4	CA
102	FNC 1	FNC 1	FNC 1	F1	F1
103	Start A	Start A	Start A	SA	SA
104	Start B	Start B	Start B	SB	SB
105	Start C	Start C	Start C	SC	SC
106	Stop	Stop	Stop	ST	ST
106	Stop	Stop	Stop	<-	<-

5.2.2.3 Code family 2 of 5

The Code family 2 of 5 knows several different symbologies. The only standardised symbology is 2 of 5 interleaved. The other variations have been developed by several companies for different purposes. Nowadays the 2 of 5 interleaved symbology remains. All others are exotic and out of date and shouldn't be used anymore for new projects.

5.2.2.3.1 2 of 5 Interleaved

The code 2 of 5 Interleaved was developed in 1972 and is used mainly in industry. This code has a high character density and because of that this code is very popular. It should however be noted that this code construction can easily lead to faulty decoding.

The B-value indicates the bar and the S-value the space (**B**ar and **S**pace).

This symbology interleaves 2 characters. The first character is coded using the bars only. The second character is encoded using the spaces between the bars of the first character. This interleaving leads to a high character density. If 8 character or more shall be encoded Code 128 is more efficient in use of space than the 2 of 5 interleaved code (only numerical code contents).

Specification of symbology and code contents

```
SYMBOLOGY       2/5 INT
CODE            255004
```

Metric information with extreme values and average value

```
Bar             - 2   -30       max   ±304 µ
Space           +31   + 6       max   ±304 µ
Average value   -18
```

The two bar values are the extreme values of the bar deviation, determined from the table - Traditional detailed evaluation (always line B B B B B).

The two spaces values are the extreme values of the space deviation, determined from the table - Traditional detailed evaluation (always 2nd line S S S S S).

The average value is the average value of all bar deviations, determined from the table - Traditional detailed evaluation.

Size information 2/5 Interleaved

```
Z-module 1013
Ratio 2. 50: 1
CPI 3. 13
```

The Z-module and the CPI value have the same meaning as for EAN/UPC and Code 128. Ratio means the ratio of the thick bars to the thin bars. The ratio value is only used for barcode symbologies made up of two bar widths.

Table - Traditional detailed evaluation

	B	B	B	B	B	Principal view 1st line of a line pair (bars)
	S	S	S	S	S	Principal view 2nd line of a line pair (spaces)
•	-41	+30	-31	+34		start character bars and spaces alternately
2	-33	-33	-35	-27	-18	first number bars only
5	+33	+27	+29	+30	+23	spaces interleaved in first number
5	-31	-30	-29	-32	-33	third number bars only
0	+36	+35	+26	+33	+41	spaces interleaved in third number
0	-27	-32	-33	-32	-31	fifth number bars only
4	+36	+34	+33	+35	+30	spaces interleaved in fifth number
•	-34	+41	-40			Stop character, 2 bars with intermediate space

5.2.2.3.2 ITF 14

ITF 14 is in principal identical to the 2/5 Interleaved code. ITF 14 has some additional restricting specifications which can be found in the ITF 14 description given in the GS 1 General Specifications. Apart from the exceptions described, the evaluation is identical to 2/5 Interleaved.

Size information ITF 14

```
MF          1.013
Ratio       2. 50: 1
CPI         3. 13
```

The magnification factor, in the same way as EAN 128, is not actually an enlargement factor, but simply the Z-module in millimetres. Ratio and CPI are identical to the information for 2 of 5 Interleaved.

ITF 14 has a size restriction (see section 4.8.3.1.2) and also a restricted range for the ratio (2.25:1 to 3.0:1, recommended 2.5:1).

The calculation of the decodability parameter is not identical to the standard decodability calcalation according the 2 of 5 interleaved standard.

The ITF 14 code has to use always a check digit.

Reliable autodiscrimination from 2/5 Interleaved is not possible. Either ITF 14 or 2/5 Interleaved must therefore be set in the symbology selection (see section 4.8.3.2).

5.2.2.3.3 2/5 Frachtpost (optional)

The 2/5 Frachtpost code is like ITF 14 a quite normal 2/5 Interleaved code. The Freight post code is used on parcels of the Deutsche Post AG/DHL. The specification can be found in the brochure "Specification of uni-dimensional barcodes for automatic scanning and distribution in the 33 DHL Express parcel centres of the Deutsche Post AG". There is a 12-digit identification code and a 14-digit sorting code. The check digit is essential, and is calculated according to a specific DHL formula (see brochure). The Frachtpost code has a specified size range and a defined minimum height. The code content must be made up according to the specifications of the Deutsche Post AG/DHL. Apart from the correct length of the contents (12- or 14-figure) and the check digit, the code content is not checked.

The evaluation is identical to the evaluation of the normal 2/5 Interleaved code. The additional criteria generate error messages if not observed.

5.2.2.3.4 Code 2 of 5 IATA (optional)

This symbology is used in the air travel industry on flight tickets and for other internal applications. With regard to layout, the symbology corresponds to that of 2 of 5 Interleaved, with the difference that other start and stop characters are used, and the spaces contain no information.

Specification of symbology and code contents

```
SYMBOLOGY       2/5 IATA
CODE            038645
```

Table - Traditional detailed evaluation

	B	B	B	B	B		Principal view 1st line of a line pair (bars)
	S	S	S	S	S		Principal view 2nd line of a line pair (spaces)
•	+ 21	- 85	+108	-175			start character (bars and spaces alternately)
0	+142	+114	- 56	+ 45	+129		Bars, character 1
	-141	-100	- 92	- 87	GAP	878	Spaces, character 1
3	+ 53	- 29	+129	+ 92	+198		
	- 79	- 96	-149	-158	GAP	909	
8	+ 21	+159	+ 79	+ 48	+149		
	-196	-111	-110	-151	GAP	827	
6	+168	+ 31	+ 3	+109	+186		
	-158	- 53	-124	-184	GAP	864	
4	+ 96	+ 77	- 1	+116	+ 17		
	- 81	-118	-132	-131	GAP	977	
5	- 7	+153	- 52	+ 92	+ 76		
	-125	- 95	- 89	- 99	GAP	986	
•	- 67	- 86	+ 70				Stop character (2 bars with intermediate space)

GAP stands for character gap, and is the width of a space between two characters. The character gap is normally printed with of one module. The width of the character gap can be varied within relatively broad limits. For this reason, the overall character space dimension is shown, instead of the deviation dimension.

The sizes and extreme values in the report are identical to the information for the 2/5 Interleaved code.

5.2.2.3.5 Code 2 of 5 5 Bar (optional)

This symbology is also referred to as 2/5 5-bar Industrial, and dates from the year 1968. One area of application for example is photo envelopes. Apart from the start and stop characters, the characters are identical to those of the 2 of 5 Interleaved code. As with 2 of 5 IATA, the spaces contain no information.

Specification of symbology and code contents

```
SYMBOLOGY        2/5 5 BAR
CODE             12348
```

Table - Traditional detailed evaluation

	B	B	B	B	B		
	S	S	S	S			Principal view 2nd line of a line pair (spaces)
•	+ 26	+108	+ 20	+ 46	- 69		start character (3 bars, 2 spaces)
1	- 28	-107	-117	- 95	+ 69		Bars, 1st character
	+129	+106	+121	+ 51	GAP	1011	Spaces and character space, 1st character
2	-118	- 1	-107	-101	- 1		Bars, 2nd character
	+113	+ 90	+ 95	+103	GAP	1092	Spaces and character space, 2nd character
3	- 58	+ 11	-116	- 93	-111		
	+156	+ 97	+ 94	+ 86	GAP	1010	
4	-101	-105	+ 27	-127	- 37		
	+105	+104	+115	+165	GAP	1093	
8	- 35	-110	- 91	- 27	-124		
	+124	+130	+ 84	+151	GAP	1047	
•	- 8	+111	-137	+150	+ 45		Stop character (3 bars, 2 spaces)

The sizes and extreme values in the report are identical to the information for the 2/5 Interleaved code.

5.2.2.3.6 Code 2 of 5 3 Bar (optional)

The character layout of this symbology differs from that of the other 2 of 5 symbologies. This symbology encodes a character in a combination of bars and spaces. This procedure is for example comparable with Code 39.
This symbology is also knows as "2/5 3 bar matrix".

Specification of symbology and code contents

```
SYMBOLOGY        2/5 3 BAR
CODE             12348
```

Table - Traditional detailed evaluation

B - Bar S - Space

	B	S	B	S	B		Principal view pro character (bars and spaces)	
•	-317	+ 32	- 51	- 36	- 53	GAP	963	start character
1	-200	+ 41	- 53	+ 27	-217	GAP	964	1st character, bars and spaces
2	- 13	+176	- 34	+ 56	-212	GAP	1015	
3	-130	+201	- 41	+ 13	- 40	GAP	946	
4	- 54	+ 47	-176	+ 80	-187	GAP	993	
8	-154	+ 11	+ 33	+173	+ 5	GAP	958	
•	-269	+ 46	- 47	+ 31	- 12			Stop character

The size of the character gap is here given as the absolute width of the space.
The sizes and extreme values in the report are identical to the information for the 2/5 Interleaved code.

5.2.2.4 The CODABAR family

The Codabar family know only two symbologies. This is the older Codabar Monarch and the newer Codabar ANSI Symbology.

5.2.2.4.1 CODABAR (optional)

This CODABAR type was developed from CODABAR Monarch. In contrast to CODABAR Monarch, and for purposes of simplification, only two bar widths are used here. This CODABAR type is also referred to as CODABAR ANSI.

Specification of symbology and code contents

CODE - TYPE CODABAR
CODE d1229d

Table - Traditional detailed evaluation

B - Bar S - Space

	B	S	B	S	B	S	B			
d	+34	-22	+ 3	+15	- 1	+46	+8	GAP	784	Start (here d)
1	+ 0	+ 6	+11	-18	-31	+42	+10	GAP	781	
2	+ 7	-18	+43	- 4	- 3	-15	- 2	GAP	823	
2	+17	-16	+ 4	+11	-12	- 8	-15	GAP	825	
9	-33	+36	+17	+10	-18	-16	+10	GAP	787	
d	+ 4	- 6	+ 4	- 3	-25	+33	+ 6			Stop (here d)

The deviations are shown alternately in bars and spaces. The absolute dimension of the character space is shown at the end.

The sizes and extreme values in the report are identical to the information for the 2/5 Interleaved code.

5.2.2.4.2 CODABAR Monarch (optional)

CODABAR Monarch was developed in 1972 by Monarch Marking Systems. CODABAR Monarch was used on photo bags and blood bags.
This symbology has 18 different bar widths, and can therefore only be printed correctly with high-resolution printing processes or special printing units similar to typewriters, which can print the different bar widths with corresponding types.

Specification of symbology and code contents

```
SYMBOLOGY       MONARCH
CODE            d1229d
```

Metric information with extreme values and average value

```
Bar             +213  - 38       max   - 94 µ
                                   Max  +188 µ
Space           +  2  -244       max   -188 µ
                                   Max  + 94 µ
Average value   +109
```

The extreme values are determined according to the same formula as for the other symbologies. The asymmetrical tolerances determine the different maximum specifications of thin or thick elements.

Size specification

```
CPI 5. 31
```

The size specification is given only in Characters Per Inch (CPI)

Table - Traditional detailed evaluation

```
 B - Bar   S - Space
     B    S    B    S    B    S    B

d    +125 -111 + 89 -131 +116 -155 + 88 GAP  1680 Start d
1    +134 -177 +105 -137 +110 -159 + 88 GAP  1705
2    +155 -139 + 97 -154 +111 -145 +114 GAP  1676
2    +120 -123 + 95 -165 +146 -132 + 67 GAP  1684
9    + 92 -101 + 94 -155 + 80 - 96 +104 GAP  1680
d    + 98 -130 +101 -155 + 97 -156 + 90           End d
```

In this symbology, the measurement values of bars and spaces are shown alternately in a line. The character gap is also here specified as an absolute dimension.

The contrast is specified as Reflectance difference (short cut Refl. Difference). This is the difference between space and bar reflectance.

5.2.2.5 Code 39 family

The Code 39 family includes Code 39 standard, Code 39 Full ASCII, Code 32, Code 39 UPU and the PZN Code. Code 32 is used on pharmaceutical packaging in Italy. The PZN Code is used in Germany on pharmaceutical packaging. The general Code 39 (including Full ASCII) is used in industry, government and trade. This code is used because of its secure code construction. Code 39 UPU was defined by the international post organisation Universal Postal Union. Code 39 UPU is optional. The other Code 39 variants are supplied as standard.

The evaluation is described below using the example of a standard Code 39.

Specification of symbology and code contents

```
SYMBOLOGY        CODE 39
CODE             *1229*
```

Table - Traditional detailed evaluation

	B S	B S	B S	B S	B			
*	+13	+36	+ 4	+19	+ 5			start character (bars)
	- 4	-31	+ 2	- 5		GAP	793	start character (spaces) and character space
1	+ 0	+50	+ 1	+40	- 1			
	- 1	-14	-31	-54		GAP	820	
2	+34	- 6	+11	+40	-10			
	-35	+36	-31	-20		GAP	818	
2	+ 8	-19	+16	+10	-10			
	-42	+47	-26	-15		GAP	784	
9	+31	-11	+30	+ 3	+22			
	-21	+ 4	-46	+ 4		GAP	772	
*	+30	+15	- 5	-31	+ 3			
	-29	-42	+ 5	+26				

As already known from some other codes, bars and spaces carry information. The combination of bars and spaces produces a character. The bar deviations and space deviations are shown in two lines, one below the other. The line with the spaces values is ended by the character space, which here too is the absolute width of the character space.

The other Code 39 variants differ in size and content specifications. Code 32 has a special feature consisting of a different code table with code compression. If deviations occur to these specifications, an error message is generated.

The size information and the metric extreme values are given in the same way as for the 2/5 Interleaved code.

5.2.2.6 Code 93 (optional)

Code 93 is a further development of Code 39 with a much better character density. Code 93 uses the same character set as Code 39. In terms of the code layout (four bar widths), Code 93 is similar to Code 128.

Each character is assigned 3 lines. The first line contains the deviations of the bars of the character from the target value (B-values). The second line contains the deviations of the spaces from the target value (S-value). At the end of the second line comes the P-value. This value refers to the character width, consisting of the bars and spaces in lines 1 and 2 and gives the deviation of a character within the code from the target width.

The third line contains the E-values. The E-values are combinations of bars and spaces and vice versa. The first E-value is the deviation of the first bar and the following space. The first E-value is the deviation of the first bar and the following space.

The third E-value is the deviation of the first space and the following (second) bar. The fourth E-value is the deviation of the second space and the following bar.

The value at the last position of line 3 is the code value character. The code value is used to calculate the check digit.

Specification of symbology and code contents

```
SYMBOLOGY       CODE 93
CODE            •  C+O+D+E 93 •
```

Table - Traditional detailed evaluation

```
      B    B    B
      S    S    S    P
      E    E    E    E    Value
•     + 99 +122 +217       47              start character
      -116 -171 -280 -129
      - 17 +  6 - 49 + 46
C     +271 +206 +170       12
      -211 -152 -123 +161
      + 60 -  5 + 54 + 18
+     +130 +252 +134       41
      -237 -168 - 36 + 75
      -107 + 15 + 84 - 34
O     + 74 +107 +177       24
      -127 -164 -122 - 55
      -  3 - 20 - 57 + 13
+     +116 +113 +238       41
      -100 -201 -209 - 43
      + 16 + 13 - 88 + 37
D     +235 +135 +150       13
      -166 -172 -106 + 76
      + 69 - 31 - 37 - 22
 +    +178 +150 +249       41
      -160 -191 -225 +  1
      + 18 - 10 - 41 + 58
E     +137 +127 +281       14
      -115 -186 -322 - 78
```

```
      +22  + 12  - 59  +95
      +181 +180  +153       38
      -142 -135  -160  +77
      + 39 + 38  + 45  +18
9     +135 +164  +149        9
      -161 -118  -145  +24
      - 26 +  3  + 46  +31
3     +154 +183  + 94        3
      -226 -141  -163  -99
      - 72 - 43  + 42  -47
W     +185 +154  +173       32          Check digit 1
      -195 -152  -124  +41
      - 10 - 41  +  2  +21
I     + 86 +142  +145       18          Check digit 2
      - 96 -154  -169  -46
      - 10 + 46  - 12  - 9
•     +190 +204  +265       47          Stop character
      -243 -194  -178  +44
      - 53 - 39  + 10  +71
```

The view of the metric extreme values and the size information are identical to the Code 128 display.

5.2.2.7 MSI Code (optional)

The MSI Code is used in the Netherlands and Belgium for pharmaceutical packaging (similar to PZN and Code 32). This symbology has only very limited self-checking possibilities and it is difficult to distinguish it from other symbologies. The MSI Code must therefore be selected as an individual code in the symbology selection (see section 4.8.3.2). The MSI Code can also contain 2 check digits.

In addition to the always present symbol check digit (last position in the symbol after Modulo 10), a 2nd check digit is sometimes used at the penultimate position, which is calculated either according to the Modulo 10 or Modulo 11 process. If a 2nd check digit is present, one of these versions must be activated under Code/Selection (see section 4.8.3.2). The symbol check digit (last digit) is always verified and does not need to be activated.

This symbology uses a coding based on the BCD system. This means that a binary will be translated directly into the barcode. Numbers from 0 to 9 can be coded.

The start character consists of only one bar and one space. The stop character has two bars and one space. A single character has 4 bars and 4 spaces. One bit of the BCD number is represented by one bar and one space with a size of 3 modules.

The evaluation gives the deviations of the bars and spaces per line alternately.

Specification of symbology and code contents

```
SYMBOLOGY       MSI
CODE            1234558
```

Table - Traditional detailed evaluation

B - Bar		S - Space						
	B	S	B	S	B	S	B	S	
•	+69	-42							Start code
1	+46	-23	+46	-11	+57	- 1	+77	-46	1st character (bars and spaces alternately)
2	+41	- 8	+44	- 6	+96	-53	+56	-17	
3	+48	-14	+50	- 8	+97	-50	+89	-48	
4	+47	+ 1	+78	-47	+36	-11	+54	-13	
5	+50	- 5	+87	-39	+38	- 5	+84	-39	
5	+45	- 6	+86	-38	+30	- 1	+69	-31	
8	+82	-52	+52	-12	+47	-18	+48	+ 8	
•	+39	-17	+47						Stop code

The specification of the size information and the metric extreme values are given in the same way as for the 2/5 Interleaved code.

5.2.2.8 2/5 Höft & Wessel (optional)

The Code 2/5 H&W is derived from the 2/5 Interleaved code. The code has a fixed length of 4 characters . These four characters are encoded into bars and spaces just as with the 2/5 Interleaved code. There is no start character. The stop character is only a thick bar. Due to the missing start character and the rudimentary stop character, this code must be activated separately for measurement.

Specification of symbology and code contents

```
SYMBOLOGY : Höft+Wessel
CODE : 2211
```

Size information
Apart from the ratio specification, no size information is given. The thin elements must have a dimension of 2 mm, and the wide elements 5 mm (Ratio 2.5 : 1). If the code deviates from this ratio, the error message "Ratio error" will be displayed.

Metric information with extreme values and average value

```
Bar             -106  -591      max ±600 µ
Space           +222  -272      max ±600 µ
Average value   -335
```

As for the Code 2/5 Interleaved, the extreme values of the bar and space deviation and the average value are displayed.

According to the specification, the code should be scanned at a wavelength of 900 nm. The contrast results of the REA PC-Scan, at either 670 nm or 635 nm, are therefore not very conclusive.

Table - Traditional detailed evaluation

	B S	B S	B S	B S	B S	
1	-158	-273	-377	+150	-506	1st character in bars
2	-222	-505	-242	-136	+257	2nd character in spaces
1	-107	-151	-592	+222	-496	3rd character in bars
2	-239	-502	-236	-188	+228	4th character in spaces
●	-109					Stop bar

Apart from the missing start character and the different stop character, the table is identical to that of Code 2/5 Interleaved.

5.2.2.9 2/5 Siemens (optional)

The Code 2/5 Siemens (or more correctly Siemens Code PT80) is derived from the Code 2/5 3 Bar Matrix. This code can be found on the rail tickets of the Deutsche Bahn AG. The data characters are coded into bars and spaces in the same way as the 2/5 3 Bar Matrix. The character table has been changed from the initial code 2/5 3 Bar Matrix. There is no start character. The stop character is only a thick bar. Due to the missing start character and the rudimentary stop character, this code must be activated separately for measurement. The 2/5 Siemens Code is normally used as a two-track code. Track 1 is a code with 4 characters. Track 2 is a code with 2 characters and one bar at a distance of 55 mm in front of the actual code (called FF bar).

Specification of symbology and code contents

```
SYMBOLOGY : 2/5 SIEMENS
CODE : 9678
```

Size information
Apart from the ratio specification, no size information is given. The thin bars must have a dimension of 1.5 mm, and the wide bars 3.4 mm (Ratio approx. 2.27 : 1). If the code deviates from this ratio, the information for bars and spaces is shown with the correspondingly large deviations.

Metric information with extreme values and average value

Bar	+193	-55	max ± 50 µ	
Space	+ 40	-56	max ± 50 µ	
Character	+302	+35	max ±100 µ	
Symbol	+323		max ±100 µ	length deviation of complete symbol
Average value	+ 48			
FF bar	- 55			(only for track 2 !)

The bar and space specifications are the extreme values. The system is identical to the display for the other symbologies. The Character specification refers to 3 bars with the intervening spaces, 2 wide and 3 narrow elements are always used. This produces a consistent character width. This combination of bars and spaces produces a number on decoding. The average value is as usual determined from the individual bar deviations. The "Symbol" specification refers to the complete barcode. If the size ratios are incorrect, this can be read off from this value.

Table - Traditional detailed evaluation Track 1

```
      B     S     B     S     B
9     +193  +15   +37   + 5   + 52   GAP  -134
                               Character+302
6     + 64  -14   +43   -34   +113   GAP  - 52
                               Character+170
7     + 44  -16   +65   -57   +1     GAP  - 38
                               Character +35
8     + 7   +40   -56   +35   +18
                               Character +43
Symbol +323
```

Table - Traditional detailed evaluation Track 2

```
      B     S     B     S     B
FF bar +41
4     +133  -109  +136  -88   +114  GAP - 57
                               Character +184
5     +116  - 82  +121  -77   +136
                               Character +212
Symbol +338
```

Track 2 always represents only 2 characters. Then comes the FF bar, which must be at a distance of 55 mm from the actual code.

5.2.2.10 Pharma-code and Mini Pharma-code (optional)

The "Pharma-code" is a control code printed on the flaps of pharmaceutical packaging and on the side of instructions leaflets. Other names for this code are the "Binary code", "Sick code", "Laetus code" or "Weber code". This code has no start and stop code. Scanning from the left to right or from the right to left will lead to different decoded code contents.
When printing this code, colours are sometimes used for the individual bars which cannot be scanned with a scanning device using red light, such as red, orange and beige.
These missing bars will lead to incorrectly decoded code content.
Prior to scanning therefore, and after selecting the Pharma-code, the correct number of bars may be entered in the menu "Symbology selection". If a bar is not recognised, an error message will be generated. Apart from the size and the lower tolerances, the Mini Pharma-code is identical.

The deviations of the narrow bars, wide bars and spaces are output successively in clear text.

Specification of symbology and code contents

```
SYMBOLOGY       Pharma-Code
CODE            49
```

Metric information with extreme values

```
Narrow bar      +125  +96   + 200/-100µ
Wide bar        +278  +103  +1000/-200µ
Space           -  9  - 99  +1500/-100µ
```

The asymmetrical tolerances must be noted.

Size information
There is no size specification for the Pharma-code, since only defined bar and space widths can be used.

Target dimensions of the Pharma-code:
Narrow bar: 0.5 mm
Wide bar: 1.5 mm
Space: 1 mm

Target dimensions of the Mini Pharma-code:
Narrow bar: 0.35 mm
Wide bar: 1 mm
Space: 0.65 mm

Table - Traditional detailed evaluation

```
 Wide bar        + 2  Space  +24
 Narrow bar      -14  Space  +15
 Narrow bar      -11  Space  -12
 Wide bar        +12  Space  -34
 Narrow bar      -12
```

5.2.2.11 Measurement program (optional)

The measurement program is used for the measurement of symbologies for which there is no decoding routine available in the PC-Scan, or also for the verification of codes which are not decodable due to extremely poor printing. No multiple measurement with average value calculation is possible with the measurement programme.

Following a measurement with the measurement programme, the actual widths of all bars and spaces are displayed, together with the reflectance values for all elements found.

First an overview is displayed.

`Overall length 99459`	Figure in µm, converted 99.459 mm
`Number of bars 25`	25 bars were found
`Maximum bar reflectance 9% in line 2`	The lightest bar
`Minimum bar reflectance 80% in line 13`	The darkest space

The lightest bar has a reflectance value of 9 % and can be found in the 2nd line of the table.
The darkest space has a reflectance value of 90 % and can be found in the 13th line of the table.

No.	Bar	Refl.	Space	Refl.
1	1274µ	9%	1131µ	84%
2	1278µ	9%	1144µ	86%
3	1265µ	9%	1141µ	82%
4	1282µ	9%	1007µ	85%
5	1255µ	9%	1164µ	84%
6	4082µ	8%	4086µ	86%
7	1285µ	9%	1002µ	84%
8	4088µ	7%	1145µ	87%
9	4079µ	8%	1153µ	86%
10	4093µ	7%	3944µ	84%
11	4098µ	7%	3971µ	83%
12	4075µ	6%	1025µ	83%
13	4095µ	6%	3952µ	80%
14	1269µ	8%	1008µ	85%
15	1275µ	7%	858µ	85%
16	1275µ	8%	4085µ	84%
17	1287µ	8%	1004µ	85%
18	1277µ	7%	863µ	83%
19	1276µ	8%	3947µ	85%
20	4104µ	7%	3667µ	81%
21	1282µ	8%	882µ	86%
22	1278µ	8%	864µ	84%
23	1274µ	7%	1010µ	81%
24	1277µ	7%	1003µ	82%
25	1280µ	8%		

If the layout of the barcode can be confirmed by a specification, manual verification against existing specifications can be carried out with the aid of this table.

6. Error messages

The error messages are divided into the following three sections in order to classify them into specific device error messages, specific code error messages and specific error messages for code EAN 128. This is intended to facilitate fault-finding and analysis.

The error messages listed in the following sections appear on the printed report as screen messages, or as error messages in the error window, which can be opened by means of the STOP icon.

The display of the measurement results shows whether a measurement lies within or outside the required specifications. An additional error message is no longer required. In the ISO/IEC 15416 or ANSI X3.182 evaluation, a failed result is shown by the result (scan reflectance profile grade) being displayed in red. On the printed report, this information is obtained from the comparison with the selected grade. In the traditional evaluation, either "Symbol Pass" or "Symbol Fail" is shown on the screen and on the printed report.
Errors in many individual parameters are displayed in red on the screen and underlined in the printed report.

The results ""Symbol Pass" or "Symbol Fail" are also indicated by acoustic signals. This is described in section 4.7.

6.1 Specific device and function error messages

9 Cannot be decoded
This error message always appears when a barcode is not properly recognised. In the simplest case, the device was probably positioned so that the barcode was not in the correct measurement position. In the more complicated case, the barcode showed such serious errors that it could no longer be identified. This could be due to specks of ink or voids which are interpreted as additional bars and spaces. This could also be other printing inaccuracies. As result the bars and spaces show such large deviations from the ideal dimensions that the barcode can no longer be identified.

15 Error! Light value greater than 100 %
If this error message appears, reflectance values in excess of 100 % have been measured. Assuming a diffuse reflecting surface, this is a result which is either not allowed or impossible.
If this message nevertheless appears, this may be due to the fact that the basic calibration is incorrect, or has not even been done (see section 3.4).
A further cause may be surfaces which do not reflect evenly, but give off total reflections. This happens if gloss materials are not lying flat under the device (e.g. films).
Textured surfaces (embossed aluminium covers, embossed labels) can also produce such effects. Barcode technology requires diffuse reflecting substrates otherwise problems will occur as described above.

299 Not enough bars
An insufficient number of bars were found in the scanned reflectance profile in order to be able to identify a barcode symbology. This error can occur with barcodes which are incomplete (e.g. printed beyond the edge of the label).

214 Multiple measurement: Symbology changed.
359 Multiple measurement: Symbology and code content changed
The REA PC-Scan distinguishes between an individual measurement and a multiple measurement (see section 4.8.7.1). In case of a multiple measurement, it is assumed that a barcode will be measured at different points. If the code is changed before completion of a multiple measurement, and a Code 39 used instead of an EAN code, this error message will appear. If the symbology is retained, but another symbol with a different content is used, the REA PC-Scan will recognise the different code contents. If several identical barcodes are present, the REA PC-Scan cannot recognise whether the same barcode or other barcodes have been measured. Barcodes with a very poor print quality or those printed on unsuitable carrier materials (e.g. brown corrugated paper) may be decoded incorrectly. In this case, this error message will also appear.

377 Error! Quality factor calculation not possible.
The quality factor is an outdated quality assessment, which weights metric and contrast results according to a certain formula. In some cases, the quality factor cannot be calculated, because the initial values are either not plausible or not available. The quality factor is outdated, and should not be used any longer.

11 Maximum enlargement
The graphic with the reflectance profile can be displayed larger or smaller (see section 4.8.6). This message appears if the maximum size has been reached.

41 Cannot open file
An attempt has been made to open a file for which reading rights do not exist.

42 Wrong file format
An attempt has been made to open a file with a different format to the internal REA PC-Scan format. The data cannot be read by the REA PC-Scan.

411 Please check laser device calibration fields
This error indicates a functional problem with the REA PC-Scan laser device. First clean the calibration fields, as described in section 3.4. A further cause for this error message may be incorrect position determination of the carriage or a defective laser diode. In both cases, repair is essential.

420 Device change, please re-calibrate...
The REA PC-Scan program has detected that another laser device has been connected. The device can only be recognised in the case of a change between the standard version and a special version with different apertures.
Care should always be taken to ensure the correct calibration values are entered (see 3.4) and the measurement accuracy is checked regularly (see section 3.6).

Error messages on serial communication

211 Communication interference, please check connection or start measurement from PC (spacebar).
20 Incorrect block
52 Interruption detected
53 Clear-to-Send time out
54 Parallel device not selected
55 Data set ready time out
56 Hardware framing error detected
57 The requested mode is not supported, or nCid not valid
58 Character lost
59 DCB
60 A parity error was detected
61 The transmit queue is full
227 Loading second dynamic reflect block
228 Waiting for second dynamic reflect block

These error messages refer to the serial communication between the PC and the REA PC-Scan laser device. If there is a problem here, this may be due to one of the following causes:

- The plug connections are not fitted correctly (loose). Check all plugs and connections for proper fitting
- There is an error in the REA PC-Scan laser device communication components. This requires a repair
- The connecting cable is broken or has a loose contact. The cable must be replaced
- There is a fault with the serial port of the PC. Another port or another PC should be tested. If this proves unsuccessful, it can be assumed that the PC is working correctly, and the fault must lie elsewhere
- Other software is accessing the port and interfering with the communication. This sometimes occurs with PC remote-control software. This software must be configured so that it cannot access the port being used by the REA PC-Scan.

No laser device found. Please select another COM port and check cable
Can't open COM x

Both these error messages indicate configuration errors. The description can be found in section 3.3.

6.2 Error messages due to faulty barcodes

212 Decoding not possible, code not activated
A barcode symbology has been detected. In the symbology selection (see section 4.8.3.2) this code has been deactivated. This may be a case of a poor-quality barcode. If this is the case, the decoder of the REA PC-Scan may be misled, and apparently detect a barcode symbology which is not present. If the barcode symbology identified is actually present, this barcode symbology has been deactivated in the symbology selection. Some symbologies are optional (software option "Optional Symbologies"). If the symbology in question is shown in grey in the symbology selection, the optional symbologies are not available.

238 Code invalid
A faulty data structure has been detected in an EAN 128 code.

239 Symbology incorrect
An EAN 128 code has been selected, but a Code 128 detected. The Symbology or the setting must be corrected.

240 Check digit incorrect
The check digit defined by the specification or activated by the user (see section 4.8.3.2.1), is incorrect. The check digit verification must be deactivated or the code corrected. Incorrect check digits can occur with badly printed barcodes, in which individual characters are incorrectly decoded.

241 Second check digit incorrect
Certain barcodes have a second check digit (EAN Instore code or MSI Code). If the second check digit does not exist and the verification is activated, or if the 2nd check digit is incorrect for the same reasons as for the preceding error message, this error message may be displayed.

242 Left Quiet Zone
243 Right Quiet Zone
Every barcode needs a clear area or quiet zone to the left or right of the first or last bar. The minimum width is laid down in the corresponding barcode specification (or standard).
The specifications and standards always define only one minimum quiet zone width without any tolerance.
To avoid a quiet zone error label design or prepress need to enlarge the quit zones to meet the effects of tolerances in the printing process or the code positioning.

247 Centre Quiet Zone
Some symbologies have an add-on code, which is separated from the main code by a centre quiet zone. This centre quiet zone may not exceed or fall below certain widths. This error message appears if the centre quiet zone width does not comply with the relevant specification.

248 Ratio error
The ratio defines the ratio between wide and narrow bars. The ratio may vary between 2:1 and 3:1. If the ratio is outside this range, this error message will be displayed. The error message can only occur for barcode symbologies with two different bar widths, such as Code 39 or 2/5 Interleaved.

249 Error intercharacter gap
Some symbologies are arranged discretely, which means that individual characters are separated by an intercharacter gap. If the width of the intercharacter gap lies outside the permissible specification, this error message will be displayed (Code 39 etc.).

250 Contrast error
The contrast error is an error message which refers only to the PCS. If the PCS value falls below the specified minimum limit, this error message will be displayed.

251 Metric error
The metric error is an error message which refers only to the metric evaluation of the traditional evaluation. As soon as a metric parameter exceeds the tolerance limits, this error message will be displayed.

252 Size error
Some Symbologies have a fixed permissible size range (EAN, EAN 128, ITF 14). As soon as the size of the code exceeds these limits, this error message will be displayed.

348 Z-module too small
This error message is a warning, which appears for all symbologies which have a lower limit size of the Z-module given in the specification (e.g. Code 39 with 191 µm).

349 Incorrect code length
This error message can appear in the case of the 2/5 Freight post code. The two permitted codes have either 14 or 12 digits . Any other code length produces this error message.

351 Check digit incorrect. Code content gives check digit 10
This error message can only appear in the case of the PZN code. Certain number sequences can produce the check digit 10. These number sequences are not permitted.

360 No check digit verification
Some symbologies can use a check digit. The use of the check digit is not compulsory (Code 39, 2/5I and Codabar etc.). In the symbology selection (see section 4.8.3.2.1), the check digit verification can be activated or deactivated for these symbologies. If the check digit verification is deactivated, this note will appear on the printed report.

361 Second check digit not verified
This note is identical to the previous error message "No check digit verification" with regard to the second check digit. A second check digit can be verified in the case of the MSI Code (setting, see section 4.8.3.2.1). There is also a second check digit in the case of the EAN 13 Instore code (see section 4.8.3.2.2). The EAN 128 code can also have additional check digits in data fields. These check digits are also verified in the course of the EAN 128 data structure checking (see also error message 241).

389 Distance FF/Symbol Target > 55000 Actual
This error message can only appear with the Code 2/5 Siemens (Track 2). The FF bar has some other separating distance than the required 55 mm.

410 Attention: Increased tolerances
This note is added if films are being measured with the setting "Digital Film" (see section 4.8.3.1.4). In comparison to the standard tolerances (Film setting) the tolerances here are doubled.

412 Info: Ratio not target ratio; Recommended 1:2.5
Code ITF 14 has a permitted ratio range of from 2.25:1 to 3:1. 2.5:1 is defined as the optimum. If the ratio is within the permitted range, but is still not 2.5:1, this note will be displayed.

413 Note! Ratio warning :
The standards for the "two bar width barcodes" (Code 39, 2/5 Interleaved, Codabar etc.) specify for the ratio a tolerance range from 1.8:1 to < 2.0:1 and from > 3.0:1 to 3.4:1. If the ratio lies within this tolerance range, this message is displayed.

Size error max 1.016 all sizes
Size error min 0.25 all sizes
Size error max 1.016 General Distribution
Size error min 0.495 General Distribution
Size error max 0.495 Internal Use
Size error min 0.25 Internal Use
These error messages can occur for the barcode symbologies ITF 14 and EAN 128. Both barcode symbologies allow certain size ranges (setting, see section 4.8.3.1) for certain applications. If the allowed range is not maintained, one of these error messages will be displayed. The comparison is made by means of the MF (Magnification Factor) information (see section 5.2.1.3) on the verification report.

Size error max 0.66 mm Retail
Size error min 0.264 mm Retail
The size range in the setting EAN for Retail (see section 4.8.3.1) was exceeded (0.264 mm corresponds to 80 %, 0.66 mm corresponds to 200 %).

Size error max 0.66 mm General Distribution
Size error min 0.495 mm General Distribution
The size range in the setting EAN for General Distribution (transport label) was exceeded (see section 4.8.3.1) (0.495 mm corresponds to 150 %, 0.66 mm corresponds to 200 %).

Size error max. 0.66 m On Demand
Size error min. 0.250 mm On Demand
The size range in the setting EAN for instore labels (see section 4.8.3.1 and 4.8.3.2.2) was exceeded. (0.250 mm corresponds to 75 %, 0.66 mm corresponds to 200 %).

423 Z-module too large
The measured barcode was printed too large, and must be reduced. This error message can appear in the case of the Freight Post code or the MSI Code.

6.3 Error messages on EAN 128 data structure

These error messages refer exclusively to the EAN 128 data structure. The data structure is specified by GS1 International

238 Code invalid
The EAN 128 code contains a general error with regard to the data structure. The data fields and the application identifiers must be checked against the EAN 128 specification.

239 Symbology incorrect
Symbology EAN 128 has been selected, but a Code 128 has been identified. In these cases the control character FNC1 immediately after the start character is missing.

404 FNC1 missing
Many EAN 128 data fields have a variable length. If this is followed by another data field, an FNC1 character is inserted to indicate the end of the data field. If the FNC1 character is missing, this error message appears. Subsequent fields are frequently detected, since the software has to "guess" in which form the data structure has been continued. The subsequent fields usually disappear on rectifying the initial error.

405 Unknown AI
An Application Identifier (AI –) has been used which is not defined in the relevant table. This data designator does not exist or it is a new data designator, which is not yet included in the software.

406 Missing characters
One data field is too short. If this is detected, this error message appears.

407 Invalid characters
Invalid characters have been detected, e.g. letters in a numeric data field.

7. Description of the evaluations

The REA bar code verification devices offer two different evaluation methods. The first method is referred to as CEN or ANSI evaluation, and the other method as traditional evaluation.

The CEN/ANSI method refers to verification standards for barcodes. The traditional evaluation refers to symbology standards or specifications. The REA ScanCheck II and the REA Check 3 allow an initial setting of which evaluation methods are to be used. The REA PC-Scan always shows all values. The selection of the evaluation method can be made via the report printout by setting which parts of the report are to be printed out.

Both evaluations each produce a quality result which **must not match** with the other evaluation. The reason for this is that both evaluations verify different criteria of the code.

Before beginning with subsequent evaluations and carrying out an error analysis, it is important to check whether the symbology (kind of barcode) e.g. EAN 13 or Code 39 etc. complies with the specification. If so, it must then be checked whether the decoded code content complies with the specification. Only if both of these is correct further verification is meaningful.

7.1 CEN/ANSI verification

The CEN or ANSI evaluation is based on several similar standards. The first standard was the ANSI (ANSI X3.182) or UCC (ANSI/UCC5) standard. A corresponding European standard (CEN EN 1635 meanwhile withdrawn) was later agreed by CEN (February 1998). The international standard ISO/IEC 15416 was published in 2001. Bar code verification devices evaluate according to these CEN, ANSI or ISO/IEC standards.
Beginning with the REA PC-Scan software release 3.26 the formerly CEN evaluation is now called ISO 15416 evaluation. The formerly ANSI evaluation is called now ANSI X3.182 /ANSI/UCC5 evaluation.

7.1.1 The standards

There are at the moment four different applicable standards:

1. ISO/IEC 15416 Automatic identification and data capture techniques – Barcode print quality test specification – Linear symbols
2. EN 1635 Barcode test specifications for barcode symbols (withdrawn)
3. ANSI X3.182-1990 (R1995): Guideline for Barcode Print Quality
4. ANSI/UCC5-1995 Quality Specification for the UPC printed symbol

Standard 1 is an international standard
Standard 2 is a European standard which has been withdrawn in favour of ISO/IEC 15416
Standard 3 is an American standard not covering EAN/UPC codes
Standard 4 is an American standard exclusively for UPC codes

The differences between these standards lie in the display method of the quality grade (CEN/ISO 4,3,2,1,0 – ANSI A,B,C,D,F) and in the barcode symbologies covered. The assessment of the individual parameters is not affected. The differences from the traditional evaluation consist in the fact that in the standards 1 to 4, the barcode is assessed from the point of view of the barcode scanner, although under defined and consistent conditions, while the traditional method places the focus on the exact metric assessment (printing precision).
The CEN/ANSI method has a quality classification into 5 grades, 4, 3, 2, 1 and 0, where 4 represents the highest quality and 1 the lowest quality grade, and grade 0 represents an error. This classification allows the definition of a quality grade which can be adapted for the requirements of an application, or to reflect the characteristics of different substrates. The traditional method on the other hand only allows the distinction "Pass" or "Fail".

ANSI/UCC5 for example describes quiet zone errors separately as an independent criterion. This standard therefore specifies more than 7 basic criteria. Technically however, this remains identical to the other 3 standards, since these only summarise these additional criteria under the parameter Decode. The result of the verification always remains the same irrespective of this.

The specified standards describe the individual parameters fully. The following description gives a brief overview.

7.1.2 Classification of the code to these standards

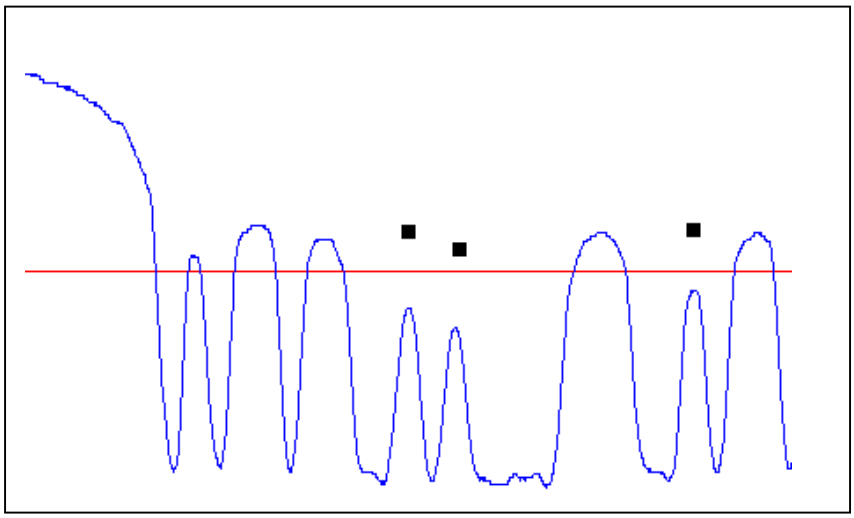
The classification of the CEN/ANSI method is explained in the following table:

EN/ISO	ANSI	Multiple measurement	Meaning
4	A	3.5 - 4.0	Very good
3	B	2.5 - 3.49	Good
2	C	1.5 - 2.49	Satisfactory
1	D	0.5 - 1.49	Adequate
0	F	below 0.5	Error

The achieved grade is determined by the following seven parameters:

7.1.3 Decode

Only "Pass" (= 4) or "Fail" (= 0).
The following errors produce an assessment of "0": check digit incorrect, quiet zone too small, incorrect code length, incorrect code content or an element definition error.
If a bar reflectance is higher or a space reflectance lower than the threshold (middle line) of a scan profile, the element determination has failed resulting in a grade = 0. If an edge of a bar or a space crosses the threshold more than once (due to noise) then this also assessed as grade 0 (Fail).



The spaces marked with square dots are elements which have caused an element determination error. The threshold is the centre horizontal line, and is calculated by the formula (R_{max} –R_{min})/2.

Element determination error is always connected with low modulation values. Causes and improvement possibilities are identical to those for the parameter modulation.

7.1.4 Minimum adjacent contrast or edge contrast (EC_{min})

The worst reflectance difference between a bar and a space in a complete barcode symbol.

[EC_{min} =R_S-R_B]

R_s and R_b are the reflectance values of individual bars and spaces. Adjacent elements (bars and spaces) are used to determine several edge contrast values. The minimum edge contrast [EC_{min}] is selected and used to determine the grade.

Grade 4 [EC_{min} >= 15 %]
Grade 0 [EC_{min} < 15 %]

The minimum edge contrast is influenced by the colours of the bar and background and by the substrate properties.
The classification Grade 4 or Grade 0 is not very conclusive if taken in isolation. The percentage value of minimum Edge Contrast and the grade for Modulation should be taken into account.

7.1.5 Symbol contrast (SC)

The difference between the highest and lowest reflectance in the complete symbol including the quiet zones.

[$SC=R_{max}-R_{min}$]

Classification

4 >= 70 %
3 >= 55 %
2 >= 40 %
1 >= 20 %
0 < 20 %

The symbol contrast is determined largely by the colours of the bars and spaces (or colour of the substrate). Only the difference is assessed, not the absolute amount of the reflectance values.
In the case of transparent substrates (usually printed with opaque white), a white substrate increases the symbol contrast. With a black measurement substrate, the symbol contrast becomes significantly smaller. The difference becomes smaller with increasing opacity of the opaque white or the substrate.
Textured, embossed or other uneven surfaces can increase the symbol contrast. The increase is "artificial", because the surface does not reflect diffusely.

7.1.6 Modulation

The ratio between edge contrast and symbol contrast

[$MOD=EC_{min}/SC$].

The modulation can be described as the evenness of the reflectance ratios of the code. The closer the edge contrast and symbol contrast are to each other the higher is the evenness of the reflectance ratios of the barcode symbol. It may happen that the modulation fails even though the edge contrast and the symbol contrast both lie within the specifications. In such a case the difference between the edge contrast and symbol contrast is too large.

4 >= 70 %
3 >= 60 %
2 >= 50 %
1 >= 40 %
0 < 40 %

The modulation is influenced by metric errors (too thick or too thin bars), an incorrectly set aperture and by substrate properties (transparency or opacity).

7.1.7 Minimum reflectance R_{min}

The requirement on R_{min} is that the reflectance (= R_{min}) of the darkest bar must be lower than half the maximum reflectance (=R_{max}) in the symbol. The only possible results are Grade 4 = "Very good" or Grade 0 = "Error". The standard defines this as follows:

Grade 4: [R_{min} =< 0.5*R_{max}]
Grade 0: [R_{min} > 0.5*R_{max}]

Whether a certain R_{min} value meets the specification depends on the R_{max} value.

With the REA verification devices the display has been changed by means of a simple formula conversion:

Grade 4: [R_{min} / R_{max} =< 0.5]
Grade 0: [R_{min} / R_{max} > 0.5]

The advantage is the fixed limit of 50 % (0.5) compared to the previous variable limit.

The assessment depends essentially on the bar reflectance, while the symbol contrast and edge contrast for example assess the difference in the reflectance values, and not so much the individual absolute reflectance value. The type of the assessment is almost identical to the PCS value in the traditional evaluation (see section 7.2.1.1). Only the limit values of the PCS value place higher requirements, and the value becomes worse with smaller figures, which is the reverse with R_{min}.

Example:
R_{min} is 40 %, R_{max} is 60 %. R_{min}/R_{max} produces 66.6 % (Grade 0) at a symbol contrast of 20 % Grade 1. If R_{min} is changed to 1 % and R_{max} to 21 %, the symbol contrast remains at 20 % (Grade 1). R_{min}/R_{max} changes significantly to 4.8 %, and is now assessed as Grade 4.

The aim of this parameter is to obtain bars which are as dark as possible. A barcode scanner usually has fewer problems in reading a barcode with very black bars (1 %) and not such a light background (41 %), as a barcode with light bars (40 %) and a very light background (80 %).

7.1.8 Defects

This parameter specifies irregularieties found within bars, spaces and light margins. This refers to light marks in the dark bars (voids) or dark marks in the quiet zones or spaces (spots). The defects are calculated as the ratio of the absolute measured defect (ERN_{max}) to the symbol contrast (SC). Basically, every barcode contains many minor defects (e.g. surface roughness). The largest of these is identified and designated as ERN_{max}.

$$\text{Defects} = \frac{ERN_{max}}{SC}$$

The maximum defect in relation to the symbol contrast is calculated.

4 = < 15 %
3 = < 20 %
2 = < 25 %
1 = < 30 %
0 > 30 %

The assessment of the defects in relationship to the symbol contrast is seen from the point of view that the symbol contrast is used to assess the useful information, and the defects represent the noise. A minimum distance between the two is required in order to be able to decode efficiently. Too large defects can in the extreme case be interpreted as additional bars or additional spaces. This leads to destruction of the code structure and produces incorrect decoding or prevents decoding completely. The measured defect values depend on the aperture setting. Assuming a geometrically identical defect, the measurement value appears greater with a small aperture than if measured with a large aperture. The reason for this is the area covered by the aperture (= light spot size) and the ratio within this area between the defect and the surrounding black or white areas.

7.1.9 Decodability

Here the metric deviations from the target value of the bars and spaces or their combinations are assessed. This judges the readability of the barcode from the point of view of the scanner. This parameter is not very conclusive as far as the producer of the bar code is concerned. The traditional evaluation should be used for the assessment of the metric accuracy for print process control. Calculation of Decodability includes only those dimensions used in the reference decode algorithm. Thus no conclusions can be drawn with regard to corrective actions or the cause of the error. Just the overall conclusion that there is a problem with the printing accuracy is possible.

Decodability is determined in relation to the barcode symbology. The result is a percentage value, which is classified as follows.

4 >= 62 %
3 >= 50 %
2 >= 37 %
1 >= 25 %
0 < 25 %

The calculation rules for the decodability result in a non-linear relationship between the measured deviations at the ideal size and the classification of the decodability. It is therefore possible to still achieve good decodability values with relatively large printing inaccuracies, and for even relatively small variations in the printing accuracy to lead to large changes in decodability. A user is able to decide if a barcode with larger printing inaccuracies is still good enough for scanning. For quality control of the printing process this conclusion risks that the code is passed as being printed accurate.

7.1.10 Result of the CEN/ANSI evaluation

The result of the CEN/ANSI evaluation is determined from the worst value of the above seven parameters (the weakest link in the chain determines the strength of the complete chain). The result is referred to as the scan reflectance profile grade. If the barcode verification device is set to single measurements, then the scan reflectance profile grade is the final result.
In case of an average measurement, the initial setting for the number of measurements must lie between 2 and 10. A maximum of 10 scan reflectance profile grades will be determined. The average value of these scan reflectance profile grades is the final result, and is referred to as the Overall symbol grade.

Average values are also derived from the seven individual parameters. These average values are for information only, and have no effect on the scan reflectance profile grade. Similar or identical values often occur as for the Overall symbol grade, so that this impression can sometimes be given.

The REA ScanCheck II displays these values as follows:

Average measurement:

Display	Printer
ANSIGR 2.2/C (D)	Overall symbol grade 2.2/C (D)
CENGR 2.2 (1)	Overall symbol grade 2.2 (1)

In case of an individual measurement

ANSIGR C (D)	Scan reflectance profile grade C (D)
CENGR 2 (1)	Scan reflectance profile grade 2 (1)

The printed report also shows the following lines:

Multiple measurement

REQ	Actual	N.D.
4	4	0

"REQ" is the setting for the required number of measurements of a multiple measurement. "Actual" is the number of scanning attempts required to achieve four measurements that can be decoded and therefore assessed. "N.D." (not decoded) shows the number of failed attempts in which the barcode could not be decoded. Normally "N.D." should be zero. If this is not the case then this information allows a better assessment of the code quality.

Example: Grade 1 is achieved in two different measurements.
In the first case, 9 attempts were necessary (N.D. = 5) in order to obtain 4 decoded and assessed measurements. In the second case, 5 attempts were required (N.D. = 1) in order to obtain 4 decoded and assessed measurements. Despite of an identical assessment, the second case indicates a better quality than the first case.

The REA PC-Scan displays the information directly in clear text. The preset grade can be seen directly on the screen, and can also be changed. On the printout, the preset grade will be shown in the line "Selected grade".

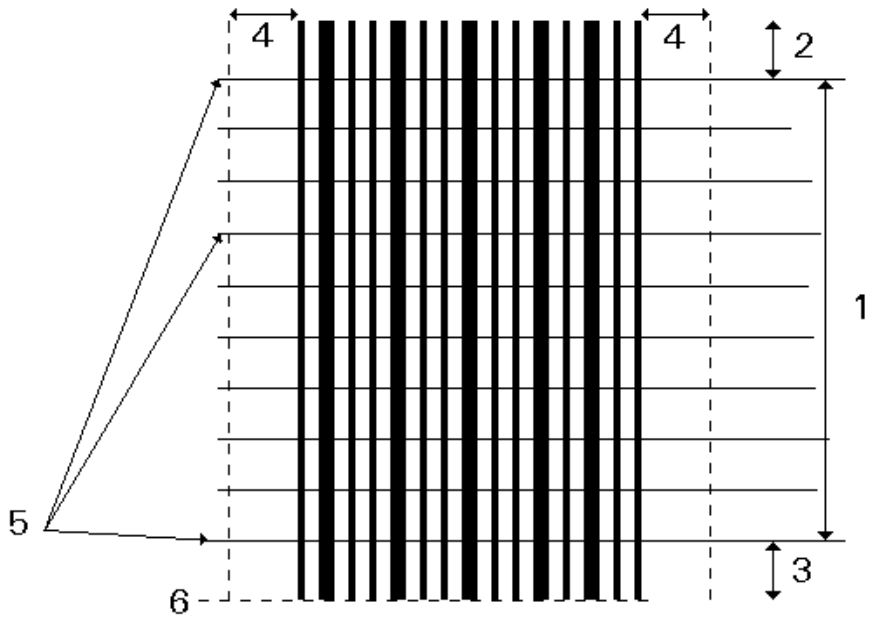
7.1.11 Selected grade

The selected grade is a pre-setting. The scan reflectance profile grade or the overall symbol grade is compared with this initial setting. If the initial setting is achieved or exceeded, then the result is in order. If the selected grade is not achieved, the result is assessed as an error.
The selected grade can be used to adapt the quality requirement to the needs of the application or the capabilities of the substrate.

In comparison to the individual measurement, the lower permitted limit for the selected grade is an average value, as listed in the table in section 7.1.2. For example, the selected grade 2 in the average measurement will still pass even though the average value is 1.5.

7.1.12 Notes on average measurement

The average measurement should always be carried out in such a way that the required number of measurements are carried out evenly distributed over the barcode height.

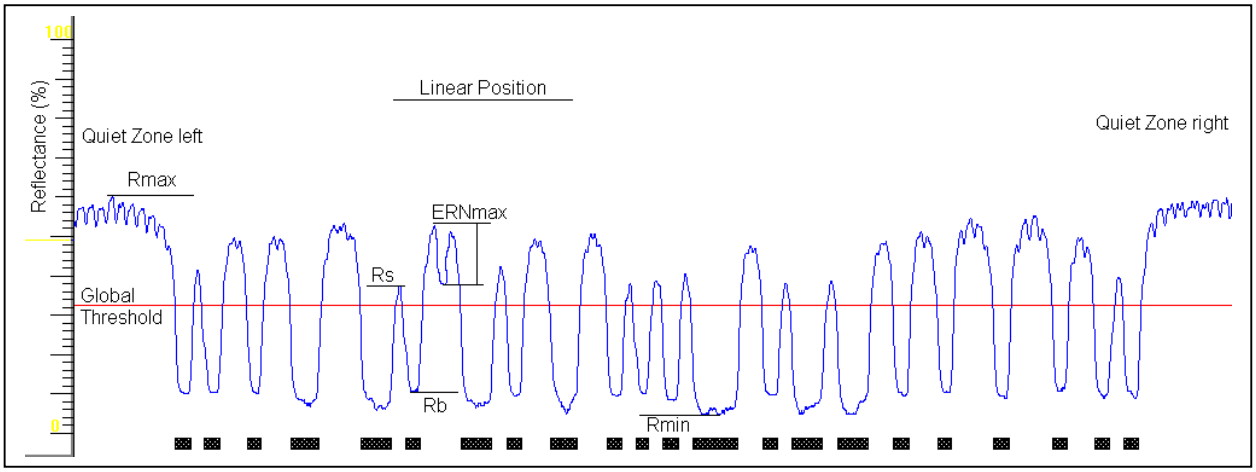


A multiple measurement per code is always recommended if large differences occur from measurement to measurement or if a visual check shows a large number of defects.
If within an average measurement some scans do not decode, the code should then be assessed significantly lower than indicated by the measurement value of the individual measurement because only successful decoded scans are taken into account for determination of the overall symbol grade. The REA ScanCheck II here offers a useful aid by giving a specified number of measurements, followed by information on how many measurements were able to be decoded, and how many were not. This criterion exceeds the specifications of the standards, but is nevertheless an important piece of information (see section 7.1.10).

The points in the profile at which the parameters are determined can be seen from the graphic in the following chapter.

7.1.13 The scan reflectance profile

The scan reflectance profile is an analogue curve, which displays the reflectance properties of a barcode as seen by the verification device. The following illustration shows an example together with a few explanations.



The measurement values from the reflectance profile are the basis for the CEN/ANSI evaluation and the traditional evaluation. R_s and R_b are the reflectance values of the minimum edge contrast. R_{min} and R_{max} are the reflectance values of the symbol contrast. ERN_{max} is the absolute defect value. ERN_{max} in relation to the symbol contrast is the displayed defect value. The metric information is also based on the reflectance profile. At certain points, the beginning of a bar or space is identified. This is shown graphically by the bars indicated below the reflectance profile.

7.2 Traditional evaluation

The traditional evaluation is an evaluation based on the standards or specifications, which describes the composition of a code and specifies the corresponding metric tolerances. In the case of the EAN/UPC code family, the relevant standard is ISO/IEC15420. Further standards are given in the bibliography at the end of this document.

The traditional evaluation produces only the result "PASS" or "Fail". No further classification is possible. Only the PCS value enables the result to be influenced by means of an initial setting (see section 4.8.3.1.3). This restriction was a further reason for the development of the later CEN/ANSI evaluation (see section 7.1).

Some standards state that the newer CEN/ANSI method makes the previous traditional method superfluous. This is correct to a certain extent if applied only to "scanning applications". The traditional evaluation is however still required for the printer or for the control of the printing process. The use of the traditional method in isolation is not recommended.

The international (ISO/IEC) and European (CEN) standards differ slightly from the ANSI symbology standard in the definition of the ratio (applies only for Codabar ANSI, 2/5i and Code 39). ANSI specifies a ratio range of 1:2.5 to 1:3.0, if the module width is less than 0.508 mm. If the module width is greater, the range 1:2 to 1:3 applies for the ratio. CEN and ISO make no distinction here, and always allow the range 1:2 to 1:3. For this reason, and depending on the initial setting, the ratio is assessed differently.

7.2.1 Explanation of terms of the traditional evaluation

The traditional evaluation verifies the contrast values, the metric values and the code sizes.

7.2.1.1 Contrast results of the traditional evaluation

In the traditional evaluation, only the PCS (Print contrast Signal) value is used as the contrast value. The PCS value is calculated according to the formula below. The method of calculation means that the PCS value depends more on the bar reflectance than on the space reflectance.

Worst case (edge contrast)		Best case (symbol contrast)
$PCS\ (EC_{min}) = \frac{R_s - R_b}{R_s}$		$PCS\ (SC) = \frac{R_{max} - R_{min}}{R_{max}}$
R_s	Space reflectance	R_{max}
R_b	Bar reflectance	R_{min}

As can be seen from the table, the PCS value can be determined either from the reflectance values of the minimum edge contrast (EC_{min}) or the reflectance values of the symbol contrast (SC). The European standard EN 1635 (meanwhile withdrawn), suggested the variant PCS(SC), if using the PCS. The later international standard ISO/IEC 15416 specifies only that it must be stated where the PCS is determined, if this is being used.

The PCS values are specified as follows:

PCS(SC)	0.98	min	0.62
Light	84 %	min	32 %
Dark	1 %	max	26 %

The number values in the left column are the measurement values. The number values in the right column are the maximum or minimum permitted values. For the PCS value, this is in this case 0.62. Most barcode symbologies have a fixed limit of a minimum 0.75 for PCS. The EAN/UPC codes have a variable limit, which is derived from a logarithmic formula in the symbology standard (EN 797 Annex E2, ISO/IEC 15420 Annex F2).

Later software versions of the REA PC-Scan and the REA ScanCheck II allow the PCS value to be deactivated completely, in addition to specifying the above two variants. Since the CEN/ANSI method provides a whole range of conclusive contrast values, the PCS measurement has decreased in importance.

The PCS value and the parameter R_{min}/R_{max} of the CEN/ANSI evaluation both assess the bar reflectance in relation to the space reflectance. The bar reflectance has in both cases the greater influence. The objective of both parameters is to achieve the best possible bar darkening. R_{min}/R_{max} has a limit of 50 % between "Grade 4, Pass" and "Grade 0, Fail". Higher number values are worse than small number values. PCS has as the limit 75 % (or variable for EAN/UPC-codes). In the case of the PCS value smaller number values are worse than larger number values. The different assessment causes stricter requirements to bar darkening if the PCS value is being used. If the PCS value is not being used, the more generous limit of R_{min}/Rmax applies as the limit for lighter bars.

The setting capability of the PCS value allows modification of the requirements based on the application as far as darkness of the bar colour is concerned.

As result the requirement to bar darkening can be assessed in three steps:

1. PCS (EC_{min}) - highest requirement to bar darkening
2. PCS (SC) - medium requirement to bar darkening
3. PCS off - lowest requirement to bar darkening (assessed by Rmin/Rmax only)

7.2.1.2 Metric results of the traditional evaluation

Metric results or measurements are measurements of the bar widths, space widths or combinations of bars and spaces. The absolute widths of these elements is only assessed as size measurement (see Size measurements below). Here only the deviations from the nominal target dimension are assessed to be able to see how much of the permitted tolerance is used up. The REA ScanCheck II takes this further to calculate percentage deviations with respect to the permitted tolerance while the REA PC-Scan shown absolute deviation values together with the absolute allowed tolerance in microns (µm).

Example: A bar width is measured as 0.33 mm. The nominal width of the bar is 0.34 mm. The permissible tolerance is 0.1 mm. The deviation between the measured bar width and nominal bar width is –0.01 mm. The deviation –0.01 mm in relation to the permitted tolerance of 0.1 mm gives a relative deviation of –10 %. This –10 % is shown on the verification report of the REA ScanCheck II. Because of this procedure, the tolerance limit is therefore always 100 %.

The REA PC-Scan shows the absolute values in micrometers (µm) with the permissible tolerance what would in this case –10µm deviation and a tolerance limit of +/-100 µm.
(1000 µm = 1 mm, 100 µm = 0.1 mm, 10 µm = 0.01 mm).

Positive values or values without a prefix indicate an increase of the measurement size, and negative values a reduction.

Depending on the barcode symbology being verified, a selection of the following parameters appears on the verification report.

7.2.1.2.1 Bar width deviation

The bar width deviations are designated on the verification report by the word "BARS". These are in all cases two number values, representing the extreme values. From all bar deviations, the two values are identified between which all the other bar deviations lie. In the ideal case, both values will be 0.

The REA ScanCheck II gives these two number values in percent, in relation to the permissible tolerance (see previous section 7.2.1.2). The REA PC-Scan shows the unchanged values in micrometers (µm) together with the permissible tolerance.

Example REA PC-Scan:

Bars +24 +5 max ± 80 µ

The identical values for the REA ScanCheck II

Bars 30 % 6 % (tolerance is always 100 %, and therefore not shown)

7.2.1.2.2 Average bar width deviation

The average value is the average value of all bar deviations used in the previous section 7.2.1.2.1 for the determination of the extreme values. The average value is only conclusive if all individual bar deviations are of the same order of size.

If individual bar deviations are positive or negative without any consistency, the average value is completely inconclusive. If only the average value is used, the average value can in such cases be misleading, because the value is 0 (which is perfect), although the individual extreme values may show large deviations (what is very bad).

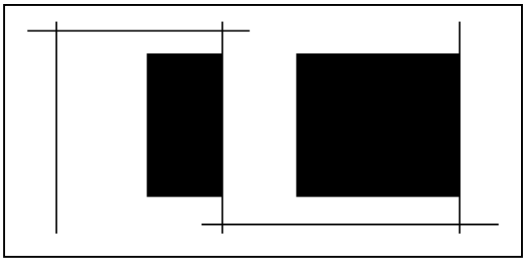
7.2.1.2.3 Spaces width deviations

These are the deviations in the spaces, which are shown as two extreme values. The display is identical to that of the bars in section 7.2.1.2.1.

7.2.1.2.4 B-values and E-values

The B-value and the E-value assess adjacent bars and spaces together. These are again shown as extreme values in the same way as the bar deviations in section 7.2.1.2.1.

B-value 1



B-value 2

The designation B-value is only used for the codes of the EAN/UPC family. The designation E-value is only used for Code 128, EAN 128 and Code 93. Barcode symbologies using E- or B-Values will be decoded by using the ratios of E- or B-values. This makes decoding more reliable and less dependent to bar width deviations.

7.2.1.2.5 P-value

The P-value is shown using the same system as for the bars. The P-value represents a complete character within a barcode symbol. This information is not given with the REA ScanCheck II, but only with the REA PC-Scan. A complete character contains several bars and spaces, which together represent individual letters, numbers or special characters.
Normally it may be assumed that the P-value is in order if the bar, space and B-value deviations are in specification, although cases do occasionally arise where this does not apply. These rare cases must be checked with the REA PC-Scan.

7.2.1.3 Size information

The size information is a number value, which indirectly specifies the space requirement of a barcode. There are various displays, depending on the symbology.

CPI — **C**haracters **P**er **I**nch. This is the number of characters per inch (1 inch = 25.4 mm). The size of a character is the P-value. This size information is always used if there is no special agreement, such as for the SIZE or MF.

RATIO — This is the ratio of the thin bars to the thick bars, and can only be used for symbologies which use only two bar widths (e.g. Code 39, 2/5i and Codabar).

SIZE — The magnification factor of the barcode symbol. This information is most important for the codes of the EAN/UPC family. For this code family, the permitted range is 80 – 200 %, or in special cases 75 % to 200 %.

MF — For other codes, such as EAN 128 and ITF 14, there is also a size specification based on the EAN 13 "Size". The number value of the MF (Magnification Factor) normally corresponds to the module width in millimetres.

7.2.1.4 Traditional detailed evaluation

The traditional detailed evaluation consists of a table, which shows the relevant individual bar, space and B- or E-value deviations for each barcode character. The description of the table arrangement is given in section 5.2.2 of the description of the printed reports. The extreme values and the average value are determined from the table.

The REA PC-Scan shows the traditional detailed evaluation on the screen. To do this, the corresponding icon must be clicked with the mouse. The difference between the percentage display and the information on the absolute measurement values between the REA ScanCheck II and the REA PC-Scan also applies here.

The traditional detailed evaluation is transmitted or printed by pressing the Print.L button on the REA ScanCheck II. For reasons of space, the traditional detailed evaluation is not shown on the display of the REA ScanCheck II. In case of the REA PC-Scan the print of table must be enabled in the menu print options.

7.2.1.5 Module width

In barcode terminology, the term module width is defined as the X-module, X-size or simply X. A module defines the ideal width of an element of a barcode. Narrow bars or spaces are normally one module in width (ideal case). The other widths are determined from the module width and the ratio (2-bar width codes). In the case of codes with several bar widths, the other bar and space widths are determined simply by multiplying the module width by 2, 3, or 4.

There is also the definition of the term Z-module. The X-module is by definition a size specified by the printer design or the print preparation. The Z-module is determined from the finished barcode as a measured size. The REA ScanCheck II only specifies the Z-module indirectly by means of the size information (see section 7.2.1.3). If the absolute measurement (in microns) of the Z-module dimension is required, the REA PC-Scan can be used for this purpose.

The advantage of the module width lies in the relative size information. All ratios can be established by specifying the module information. Only during application must the module width of for example, 0.25 mm or 0.5 mm, be specified. If a quiet zone must be 10 modules in width, this gives in this example either 2.5 or 5 mm as the actual necessary dimension.

7.2.1.6 Print prepress stage

The design is normally created in the print prepress stage. This design is applied directly to the print platen in the digital printing process, or otherwise indirectly by means of a film master. In order to minimise errors during the print prepress stage, particularly high accuracy requirements are placed on the barcode at this stage. Bar width deviations of max. ± 5 µm are allowed on a film master.
The film is not assessed according to the process of the CEN or ANSI evaluation, since contrast evaluation makes no sense at this point.

In order to show the size ratios, the following table shows various resolutions using the example of an EAN code:

Resolution of film or graphic

Resolution	Dot size	Dots at 100 %(SC2)	-1 dot	+1 dot
300 dpi	84.7 µm	4 (102.6 %)	77 %	128 %
600 dpi	42.3 µm	8 (102.6 %)	90 %	115 %
1200 dpi	21.2 µm	16 (102.6 %)	96 %	109 %
2540 dpi	10 µm	33 (100 %)	97 %	103 %

In order to produce bars and spaces without width interpolations, only whole-number multiples of the dot size are allowed.
A further difficulty is the fact that a reduction or bar width increase is carried out for the characters 1, 2, 7, 8 by 1/13 of a module (applies only for EAN/UPC codes). With 100 % size , 1/13 of a module is 25.4 µm. With a resolution of 2540 dpi, this dimension can no longer be displayed. Either 20 µm or 30 µm can be used. If reduction is carried out in this way, the film is already almost at the limit of the permissible tolerance. The highest possible resolution should therefore be used. All interpolations, edge-rounding processes or similar should not be used on the barcode.

The REA ScanCheck II does not have the required measurement accuracy for measurement of film masters. The REA PC-Scan should be used for this application.

7.2.1.6.1 Quality improvements for film masters

In contrast to printed codes, the quality requirements on film masters are defined differently. Printed codes are assessed according to the so-called CEN method (to ISO/IEC 15416) and the so-called traditional method (in the case of the EAN code to ISO/IEC 15420). Requirements on film masters are specified in the standard ISO/IEC 15421. This standard defines very low metric deviations. A verification device must therefore have correspondingly high measurement accuracy.

The assessment of a film master using the criteria for printed codes is not feasible. The contrast results are not comparable, because the target material and the film master material are not comparable. Metric results are misleading, because in the film master, corrections for the print gain are taken into account.

Film masters may demonstrate the following errors:

- Metric errors
- Size errors
- Systematic errors
- Content errors

Content errors occur for example in an incorrect coding appears in the code due to typing errors or transmission errors.

Systematic errors include such things as e.g. check digit errors, quiet zone errors, errors in the code height or code positioning. Checking of the code height and code positioning can only be carried out by means of a manual, visual check. Check digit errors occur due to incorrect entries or transmission, which must then be corrected accordingly. Check digit errors can also occur if the barcode demonstrates very large metric deviations, which lead to faulty decoding and thus to incorrect character sequences.
Quiet zone errors occur frequently. The quiet zone specifications of the relevant symbology standard must be observed. It should also be noted in the case of quiet zones that the specifications always only define the minimum dimension of the quiet zone. Every printing process and possible further finishing process (folds, weld seams etc.) has certain tolerances. These tolerances must be observed if applicable to the quiet zone area, and the quiet zone should always have the minimum width, plus these tolerances. It should also be noted that the quiet zone width depends on the code size.

Size errors are normally errors in the definition (incorrect size specified) or specification error, such as code sizes smaller than 80 % or larger than 200 % in the case of the EAN code.

Metric errors are bars, spaces and bar positions that do not comply with the specifications. A primary cause is the print gains caused by the specific printing process. Print gains are compensated for on the film master by a bar width reduction (Abbreviation BWR). In rare cases, a bar width increase (BWI – Bar Width Increase) may be necessary. The machine specifications should specify the print gains. The direction of the code (picket fence or ladder) also has an effect on the print gains.
The print gains are less in the case of picket fence orientated codes than for ladder orientated codes (in relation to the printing direction). When these values are known, the BWR-value is entered into the barcode design program (in pixels or sometimes in µm or mil). The film master verification device also receives this initial setting, in order to obtain correct verification. Faulty settings of the bar width correction can be seen from the very even bar width displacements. Film exposure systems can demonstrate an offset of up to ± 20 µm. This offset can be corrected by means of a correspondingly adjusted bar width reduction.
If the end product consists of translucent materials such as film used for packaging a light coloured product, the Modulation parameter can be influenced by the bar width reduction (modulation is only advisable for printed codes). This is done by a specific increase of the bar width reduction (up to a maximum of a value which together with the bar width variations, does not exceed the tolerance limit). The reflectance properties are positively affected for the Modulation parameter.

Further metric faults may manifest themselves in the form of very irregular bar widths, space widths or bar position variations. These errors are usually interpolation errors. Interpolation errors are caused by enlargement or reduction of the barcodes due to graphic processing. Every processing stage causes inaccuracies due to interpolation errors because everytime the new size and internal barcode relations are recalculated. Barcodes images for prepress use must always be produced in the correct size and applied without further changes.

Further problems can occur due to different resolutions at the individual stages up to the point of film exposure. If the initial graphic has a resolution of 2540 dpi, and the graphic then undergoes prepress processing which for reasons of speed converts the resolution to 300 dpi, and the exposure is then set to 1800 dpi, each of these stages will create interpolation errors due to the resolution conversion. The film master will show considerable deviations, which initially appear difficult to explain. Every processing stage should therefore work with the same resolution. A further source of errors at low resolutions is an unsuitable code size. At a resolution of 200 dpi, all elements can only be whole-number multiples of 125 µm, and at 300 dpi only whole-number multiples of 84.67 µm. If the barcode does not maintain this pattern, this will result in unexpectedly large deviations.

If the accuracy of the processing is to be checked for an EAN code, this can be done as follows:

The initial setting for all stages is assumed to be 2540 dpi. This gives dot sizes of 10 µm, because 1 inch = 25.4 mm, and 25.4 mm divided by 2540 gives 10 µm. In EAN codes, the characters 1, 2, 7 and 8 may not be used. A permissible sequence is for example 3034569034555 (including check digit). The code can be set in module widths with whole-number multiples of 10 µm. Starting from size 1 with a module width of 0.33 mm, sizes from 80 % to 200 % are allowed. This gives a permitted range for the module width from 0.264 mm to 0.66 mm. The resolution 2540 dpi in 10 µm steps allows the following module widths: 0.27, 0.28, 0.29, 0.30 .... 0.66 mm. Converted into the percentage EAN code size, this gives jumps of approx. 3 % in size.

If the characters 1, 2, 7 and 8 are also to be used, it should be noted that for these characters, a bar width change of 1/13 of the module width must be applied. Assuming that at 2540 dpi 1/13 of the module width will result in 10, 20, 30 .... µm, the code sizes will be calculated according to the following table.

1/13 module	Module width	Magnification factor	Status
10	130	39.4 %	too small
20	260	78.8 %	too small
30	390	118.182 %	allowed
40	520	157.576 %	allowed
50	650	196.967 %	allowed
60	780	236.4 %	too large

If these code sizes are set, the film masters should be of almost perfect quality. At the resolution assumed here, any bar width reductions should also only be made in 10 µm steps.

If film masters are to be measured with the REA PC-Scan, it should be taken into account that the PC-Scan also measures film masters using a reflective method. This method requires a light coloured substrate for the film. The substrate used should always be a material such as a very smooth, matt white photographic paper to avoid that this substrate does cause any falsification of the measurement results. The remaining inaccuracies is compensated by film calibration on the selected substrate.

8. Interpretation of verification results

8.1 General

This chapter is intended as an aid for the interpretation of verification results. Because of the many different printing processes used, this description can only be a guideline, which may not be correct and complete in every case.

The sequence of the parameters is divided into metric results and contrast results, instead of by the evaluation types (CEN, ANSI and traditional). In order to obtain more detailed information, a bibliography is provided in the following chapter 9.

8.2 Contrast and metric results

Contrast
REA barcode verification devices have different parameters for contrast evaluation. In the traditional evaluation, the bar and space reflectance is measured. The PCS (Print Contrast Signal) is calculated from these reflectance values. The user also has the facility of choosing between the worst and best contrast case. The basis for the worst case is the reflectance values of the minimum edge contrast (EC_{min}). The basis for the best case is the reflectance values of the symbol contrast (SC) (see also section 7.1.5).

If the PCS-value lies outside the tolerance, this is due either to the bar or space reflectance. A reduction of the bar reflectance has a greater influence on the PCS-value. Depending on the printing process or material being used, it may be necessary to increase the space reflectance and/or reduce the bar reflectance. EAN/UPC codes have a variable limit for the PCS-values. The other codes have a fixed limit of 75 % for the PCS.

The PCS assessment can be deactivated if demand for bar darkening is low.

The CEN or ANSI evaluation additionally defines the parameters edge contrast, symbol contrast, modulation and R_{min}. The modulation is calculated as the ratio between the edge contrast and symbol contrast. The reason for too low an edge contrast may be too low a contrast in general or uneven printing. A further possibility may be too wide bars or spaces. A too large aperture also lessens the edge contrast. Substrate characteristics influence the edge contrast. The symbol contrast is a value which gives information on the maximum contrast difference of the barcode. If this value is too low, either the bar reflectance value must be reduced or the reflectance of the spaces (background substrate) increased (of both).

The modulation can be interpreted as unevenness of the bar or space reflectance. If this value is too low, this means that the difference between the edge and symbol contrast is too great. One possibility for improvement is a higher density of the background colour (or the substrate in case of e.g. plastic pots).
R_{min} is displayed by REA verification devices as the relationship R_{min}/R_{max}. R_{min} should be the same as or less than $0.5*R_{max}$. If this is not the case, the bar reflectance is too high. This can be caused by unsuitable bar colours (red shades) or thermal-paper.

Metrics
The **metric** measurement checks whether the width of a bar or space, or the combination of both, lie within the specification. REA verification devices give as the measurement value the deviations from the specified tolerances. These can be absolute values (REA PC-Scan) or values in relation to the allowed tolerances (REA ScanCheck II and REA Check 3). The CEN and ANSI evaluations use the deviations as the basis for the calculation of the "Decodability" parameter. The decodability provides information on how well a code can be decoded, based on metric accuracy. The measurement value decodability does not however provide the reason for this. For analysis it is necessary to turn to the traditional evaluation results based on symbology standards.

Before attempting to optimise the printing process, the master film should first be checked (print prepress stage). The resolution is particularly important. A low resolution restricts the size selection severely (see section 7.2.1.6). In all printing systems which use graphics for the transfer to the printer, interpolation problems can cause difficulties. Special attention should be paid to Windows PC and Windows printer drivers. Graphics are often interpolated without any possible control by the user. Barcode True type fonts do not recognise any of the printer characteristics. This is the reason why Barcode true type fonts produce often unacceptable results.

8.2.1 Thermal-printing

This printing process is used by many label printers. Better models offer the facility of printing either thermal-direct or thermal-transfer labels. Thermal-printing in the form of thermal-transfer or thermal-direct printing works with a print head equipped with individual heating elements over the complete printing width. Depending on the resolution, the individual heating elements may be larger or smaller. With these heating elements, the image is formed directly onto the thermal-sensitive labels, or the ink is transferred thermally onto the label from a ribbon running between the print head and the label.

8.2.1.1 Thermal-direct contrast

Thermal-direct printing produces bars printed in a deep black. The problem is however that these bars only appear as deep black to the human eye. To the scanner they appear rather grey, since the printed areas actually have a rather dark reddish brown tone. In order to improve this, the substrate can be changed, since the reflectance value of the bars depends on the temperature-sensitive chemicals in the paper. A further possibility is that the characteristics of the thermal-paper are unsuitable for the printer. A paper with either higher or lower sensitivity or final colouring can be used instead. Some papers with a very high thermal sensitivity become lighter again if too much heat energy is applied.

The print quality is also influenced by the paper type, the type of thermal-sensitive chemicals, the printer type, the printing speed, the heat energy and the printing direction. The temperature-sensitive chemicals can be green, blue or red as the basic colour. Papers with green or blue temperature-sensitive chemicals are more suitable than papers with reddish temperature-sensitive chemicals (due to the red light source used by barcode scanners and verifiers).

8.2.1.2 Thermal-transfer contrast

In the case of a good match between labels and the "ink" ribbon, thermal-transfer printing can achieve a very good print quality. In the event of contrast problems, these are usually caused by an incorrectly set printer or by an unsuitable combination of labels and ribbon (e.g. paper label and resin ribbon). The contrast is influenced by the heat energy, the printing speed and the pressure. If no adequate improvement can be obtained by changing the printer settings, then changing the labels, the ribbon or ultimately even the printer itself must be considered.

8.2.1.3 The metric aspect of thermal-direct and thermal-transfer printing

These printer types use a thermal-printing head. Every dot is represented by a heating element. These elements are square in shape ad arranged next to each other in a line. This enables the printing of very sharp edges.
Metric problems can be caused by too high heating temperature. Since more ink is supplied, the bars become wider. The temperature setting should be reduced keeping in mind the defect value.
A printout which shows many defects may be caused by an unsuitable combination of labels and ribbon. It may also be that the printing speed is too high. If a speed reduction provides no improvement, a different label/ribbon combination should be tested.

The barcode can be printed in a ‘picket fence’ (horizontal) or ‘ladder’ (vertical) formation. The ladder formation is more difficult to set, since the smearing effect caused by the too slow cooling of the heating elements increases the bar width, and not the non-critical bar length. The ladder formation has the advantage that the barcode can still be used if one dot in the printing head is defective. Screen scanners can however have problems with this, because the barcode is divided into two halves. In order to improve the quality in this case, the speed should be reduced, and the temperature set very accurately. The pressure exerted by the print head on the label and ribbon can be adjusted. This affects the "Defects" parameter.

8.2.1.4 Laser printers

Contrast
Laser printers create problems if there is only little toner left or if the drum needs to be changed.

Metrics
The black bars are produced by small toner particles of irregular size. These toner particles have, in geometric terms, a very irregular shape. When printing barcodes, this leads to blurred edges. If this problem occurs, it can only be remedied by using a printer with higher resolution or an optimised size setting of the barcode, taking into account the printer resolution. Irregularities will thus cause fewer problems. In case of laser printing under Windows, it can often be observed that the software and printer combination is not actually able to make full use of the available printer resolution. This leads to a much poorer print quality than the nominal resolution of the printer would indicate. In this Windows combination, barcodes are normally created as graphics, and then printed as bitmap images. The graphics are then adapted to the printer resolution. Adapting the barcode graphics to the printer resolutions leads to unacceptable results, because defined ratios of bar widths and space widths are destroyed if the graphics is adapted.
Laser Printer use usually a dot overlapping to get smoother edges. A bar code printing software needs to recognise dot overlapping because otherwise the required defined ratios of bar and space widths are also destroyed.

8.2.1.5 Inkjet printing

Contrast
With inkjet printing, contrast problems occur when a highly absorbent substrate is used, or too little ink is applied. The carrier substrate causes many problems due to the direct print onto the substrate, and therefore has a major influence on the print quality (e.g. defects, varying absorbency and brightness). In industrial applications for example, packaging is labelled directly using inkjet printers. The quality of the packaging paper varies greatly, which causes contrast problems. This can be remedied to a certain extent by the adjustment of the printer.

Metrics
Inkjet printers normally print edges with a slightly irregular outline. This is caused by the absorbency of the paper and the unevenness of the individual dots on the paper. This can be remedied by using another type of paper, higher printer resolution or faster-drying inks.
A further problem is that the individual ink dots appear larger or smaller, depending on the carrier material. If a lot of ink is absorbed, the dot will be larger. If it does not, the resulting dot will be very small. The print resolution results directly from the dot size. The effective resolution of the printer thus depends on the substrate being printed. In practice therefore, the printer must be individually set for every different type of substrate to be printed.

Batch variations may also necessitate a new printer setting.

Ink-Jet printer may also use dot overlapping like laser printers. If so the printing software needs to recognise this to be able to create fitting bitmaps of the barcode to be printed.

8.2.1.6 Dot-matrix printing

Contrast
This type of printer is in principle very unsuitable for barcode printing, since no straight edges can be printed. Contrast problems arise due to wear and drying of the ink ribbon.

Metrics
In dot-matrix printing, metric problems are caused by the inconsistent shape of the individual dots. With older printers, the problem is exacerbated as the needles become displaced with the increasing age of the printer. If problems occur here, another type of printer should be considered, such as a thermal (transfer) printer, laser printer or inkjet printer.

8.2.1.7 Photo-setting

This printing process works with a high to very high resolution, and the classical errors practically never occur. The errors are therefore usually to be found in the artwork or originals.

8.2.1.8 Relief printing (letterpress, flexo-printing etc.)

Contrast
If contrast problems occur with this printing process, this is usually attributable to the type of paper used or the colour combination for bars and spaces. Flexo-printing is often used for printing on packaging and films. Carton packaging has a rough, brown surface. This results in poor reflectance values for the spaces. On films, the background is printed in white, and the bars printed in black on the white surface. Due to the limited quantity of ink that can be applied, the density of the white ink is restricted.
As a result, the packaged material has a major influence on the barcode quality because it looks through the low opacity ink. In order to achieve better contrast results, the background white must be printed onto the film with the maximum possible density (more pigment and/or layer thickness).

Metrics
The main cause of metric errors in relief printing is the inevitable print gain associated with this process. The print gain also increases with use. For the barcode, this must be compensated by applying bar width reduction (BWR) in prepress. The BWR should be selected so that the bars are initially too thin, and at the end of the function time (or usage time between cleaning intervals) too thick. Both extremes should lie within the tolerance of the traditional evaluation.
In the case of flexo-printing, problems also occur due to the compression or widening of bars (print platens are made of a flexible material). These effects can be reduced by a frame around the barcode, or by varying the pressure.

8.2.1.9 Gravure printing

Contrast
Contrast problems occur here due to the selected colour combination. When printing on film, the problems are similar to those described in section 8.2.1.8 for flexo-printing. Gravure printing has the advantage that more ink can be applied to the material. This is advantageous in the case of transparent materials, which have to be printed with opaque white.

Metrics
Most problems with regard to gravure printing occur due to too low resolution. The screen resolution should be approx. 100 lines/cm. If a code produced by gravure printing is being measured, the bar width changes with the position. Sometimes the full width is measured (dot), and at other times the "trough" between two dots. Sometimes a narrow isolated line can be seen in front of a bar. This leads to defects and should be avoided. Modern gravure processes (laser-gravure) allow edge-smoothing, reducing this effect to almost negligible proportions.

8.2.1.10 Screen Printing

This kind of printing process allows to transfer a heavy weight of ink to the substrate. This is very helpful to improve Modulation or Symbol contrast values on transparent substrates. The other aspects appear similar to gravure printing.

8.2.1.11 Litho printing

Contrast
Litho printing offers the possibility of printing high quality barcodes. Problems can be caused by too little ink or unsuitable colour combinations.

Offset litho printing is used for example for the printing of plastic cups. This type of printing works at a very high printing speed. The quantity of ink and the resulting ink density is low. In this type of printing process, it is particularly important to print the barcode in the printing direction. In case of contrast problems, higher pigment content in the plastic is helpful for white cups.

Metrics
Litho printing allows very accurate printing with low print gain.
For small codes (e.g. EAN codes < 100 % / SC2) this low print gain should be taken into account. Dry offset printing is usually used for plastic cups. The shape of the cups affects the metric accuracy of the barcode and should also be taken into account wherever technically possible. Metric errors in offset printing apply usually directly to the prepress stage.

Offset litho is modified for printing on plastic cups. The image is transferred first to a rubber blanket and then from the rubber blanket to the plastic cup. The shape of these plastic cups and the flexible rubber blanket influences the metric accuracy of the bar code and should be taken into account. The high speed of this printing process also decreases metric accuracy. The machine has to be adjusted and maintained very well to get acceptable results.

8.3 Defects

Defects in the code include either light areas in the bars (voids) or black dots in the spaces (spots). These defects are caused by a poor ink application or rough paper. Various corrective actions can be taken, depending on the printing process:

Letterpress printing:	Use a different paper or increase ink application
Flexography:	Increase pressure (not too high, to preserve the metrics)
Thermal/thermal-transfer printing:	Use a different paper, higher temperature, different ink ribbon, higher pressure, lower printing speed
Corrugated	Use labels or whiten the substrate before printing
Screening	Defects can appear with screening in the spaces with bar colors. In general the bar code background should be a solid colour.

The influence of the measurement aperture must be taken into account with regard to the defects. The larger the aperture, the lesser the defects. Instructions on the aperture selection are given in the first chapters of this manual.

The assessment of the defects in relationship to the symbol contrast (see section 7.1.5 and 7.1.8) should be seen from the point of view that the symbol contrast is used to assess the useful information, and the defects represents the noise. A minimum distance between the two is required in order to be able to decode efficiently. Too large defects can in the extreme case be interpreted as additional bars or additional spaces. This leads to destruction of the code structure and produces incorrect decoding or prevents decoding completely.
The measured defect values depend on the size of the aperture. Assuming a geometrically identical defect, the measurement value appears greater with a small aperture than if measured with a large aperture. The reason for this is the area covered by the aperture (= light spot size) and the ratio within this area between the defect and the surrounding black or white areas.

The reaction of a scanner to defects depends on the one hand on the type of the defects, and on the other on the scanner design. The scanner aperture of a laser-scanner depends on the scanning distance. At larger distances, the defects are no longer seen.

Apart from the aperture size, defects are also influenced by the following printing errors or substrate properties:

White or light marks or lines in the bars (voids)
The causes for this depend on the relevant printing process. In thermal-transfer label printing, vertical or horizontal lines can be caused by a dirty print head or broken elements in the print head. If marks appear in the bars, this is caused by too little colour/ink application. This is frequently due to electrostatic charging of the label material.
If in thermal-or thermal-transfer printing the printing speed is too high, the pressure too low or uneven, or the temperature setting of the print head too low, this will cause defects. These normally appear as irregular marks.

In conventional printing processes (offset, flexo-, gravure printing) defects occur due to poor colour/ink application. In flexography these are typically due to defects in the middle of the bar (pressure too high). In offset or gravure printing, defects in the bars are rather untypical. If defects do however appear in the bars, the colour/ink application or supply should be checked.

Dark marks in the spaces (spots)
Defects in the spaces occur for example with inkjet printing due to ink splashes. In the other printing processes, ink splashes from the bars can get into the spaces, for example due to dirt.

Printing errors
Printing errors are often found in packaging printing. At the design stage attempts are often made to make the barcode less conspicuous by its colour. If colour progressions are used, defects occur when the screen progressions consist of black, blue, green or dark brown dots. Colour progressions are only allowed with space colours, and only then when the colours are composed with particular care.

If the barcode is placed on a light coloured area, and a green, blue or black frame then printed around it, a subtle quiet zone error can cause a defect. Such a case can be recognised by means of the reflectance profile. Basically, the quiet zone widths should always be dimensioned for the size-related minimum dimension, plus a tolerance for all present inaccuracies.

- Constricted margins lead to defects (letterpress/relief printing)
- Shadow lines caused by the production of a gravure printing cylinder with mechanical stylus cause defects

- Bar printing using a screen instead of a spot colour
- "Pearly colours" due to such factors as too high a pigment content in the printing ink. This effect can be caused by attempts to improve the modulation
- Registration problems lead to light or dark lines at the bar edges

Material defects
Material defects are caused either by an uneven surface or colour differences in the surface.

Uneven surfaces: embossed metal covers, textured labels (wine bottles and other spirits), in-mould labels with "foam effect".

Carrier materials with "drawing". A typical case is brown, corrugated paper. The paper fibres are distinctly different in colour. These differences lead to large defects.

8.4 Decode

This parameter checks the quiet zones, the check digit and the element definition. In some cases, the code length is also verified. If an error is present here, this is usually due to the design. Special attention must be paid to the quiet zones. The quiet zone definitions are minimum sizes without tolerances. In the print prepress stage therefore, the printing and position tolerances must be added to the quiet zone dimension.

8.5 Modulation

Problems with the modulation are caused by substrate properties and by metric problems. Modulation assesses whether the reflectance values of the bars and spaces have similar values, or whether the values demonstrate major deviations. Low differences in the reflectance values lead to good modulations values and vice versa.

If the bars of a barcode are printed too wide, this will naturally make the spaces narrower. This reduces the minimum edge contrast (EC_{min}), while the symbol contrast (SC) retains its original value (modulation is EC_{min}/SC). The cause of this behaviour is the size of the measurement aperture. If the spaces become narrower, the aperture size approaches the space width. If the spaces are deliberately made wider, the modulations values are usually also increased again. If this makes the bars too narrow, this in turn reduces the modulation value. The effect on the bars is significantly less than on the spaces.

Further problems with the modulation can be caused by the substrate. On films, a white field is normally printed first, and the barcode then printed on top of this field. If such a barcode is measured against a white substrate, this white substrate reflects the light, which affects the modulation. In the wide spaces this increases the surface reflectance more strongly than in the narrow spaces. This creates larger differences between the symbol contrast and the edge contrast, and thus poorer modulation.

The measurement aperture should never become larger than 80 % of the module width. If the aperture gets any larger, the light spot of the laser becomes almost as large or even larger than narrow bars or spaces. Since the reflected light is then made up of the space or bar and the adjacent, the space appears darker, and the bar lighter.
This affects the edge contrast, while the symbol contrast remains almost unchanged. Consequently the modulation again deteriorates.

The following possibilities exist in principle for improving the modulation:

1. The density (opacity) of the printed white background must be increased as far as possible. This can be achieved by means of greater pigmentation and/or increased layer thickness. In the case of thick-walled, coloured materials, an additional white field can also be printed on the material and/or the material itself coloured more strongly.
2. If the code is enlarged, the narrow spaces become wider, thus reducing the negative effect on the modulation. An effect is only achieved if films are measured on a white substrate or thick-walled, light plastic substrate.
3. If the bar width reduction (BWR) is increased more than actually necessary, the spaces become wider. This therefore achieves a similar effect to that described under point 2. In this case too, this only has an effect on light substrates or thick-walled, light plastic substrates.
4. The aperture of the verification device must be correctly adjusted.
5. Bar deviations and other printing inaccuracies must be avoided as far as possible.

If the barcode patterns (films and thin materials or transparent materials) are measured once on a black substrate and once on a white substrate, it can then be assessed whether measures according to point 2 and 3 above have brought about any improvement. If a low symbol contrast and good modulation are measured on the black substrate, and vice versa on the white substrate, measures 2 and 3 can be applied. An essential requirement in this case is a white substrate behind the barcode and substrate.

If poor modulation values are also measured on the dark substrate, this may be due to an incorrect aperture setting or inaccurate printing.

If the carrier material with the overprinted barcode is laminated, this always has a negative effect on the modulation. In such cases, a different laminating material or a larger barcode may help.

8.6 Not decoded Barcodes

If a barcode cannot be decoded by the REA barcode verification devices, this means that the metric and/or contrast values must be far outside the specification. Another possibility is an invalid code, which may have been caused by missing dots or errors in the print prepress stage. The colour combination (including background influences) should in this case be checked. The metric arrangement should then also be checked. If this is in order, it should be checked whether too many defects are present, or whether screen dots have been printed in the spaces. A character set table is helpful in this case to check whether any bars are missing.

In the option "Measurement program", the REA PC-Scan offers an efficient option or the analysis of undecodable barcodes. This option is however not available for the REA Check 3 and the REA ScanCheck II.

Uneven substrate surfaces often lead to undecodable codes, because the uneven areas do not reflect the light of the verification device smoothly and diffusely, but in a directional beam. From the scanner's view, this creates additional bars and spaces, which alter the code structure.

8.7 Materials with special features

The following chapter will give some help if the substrate material itself is the reason for a quality problem.

8.7.1 Labels containing metal

These labels consist of paper labels coated with different-coloured aluminium foil, on which the printing is located. This gives the label a metallic effect, which is intended to give the product an enhanced appearance. Barcodes printed on such a label have a low symbol contrast (SC) in comparison to normal paper labels. The metallic layer acts like a mirror, and also makes the white of the barcode background appear greyer. If the white background also has holes perforated in it, additional defects also occur.

As long as no special quality requirements have been specified by the customer, no further special measures are needed. If at least grade 3 must be achieved, the white background colour should contain a high level of pigment (in order to increase the density). In some cases, the background colour has to be printed 2-3 times.

8.7.2 Film

There are many different types of film. Some are transparent, while others are white or of different colours. Some have a metallic surface like the labels described in section 8.7.1.
Transparent films require the printing of a white field behind the barcode. Depending on the packaging contents, the code quality can vary over a wide range. If the packaging contents are white, yellow, orange or red, then these colours make the white of the barcode background lighter for the scanner. This improves the parameter symbol contrast (SC), since more light gets back to the sensor in the light zones and the wide spaces. In the narrow spaces, a proportion of the light is reflected by the packaging contents onto the rear of the neighbouring bars. This light is lost, and the contrast for narrow spaces significantly reduced. The parameter edge contrasts, and consequently the modulation, are reduced. This can be improved by increasing the density of the background colour. Another possibility is a larger code or a defined bar width reduction, in order to make the narrow spaces wider.

If this same film is used for a product with black, green or blue packaging contents, the symbol contrast (SC) will be significantly reduced. This also applies in the case of an empty area behind the barcode. Empty areas appear black, since they reflect no light. In this case, only a background colour with increased density will help to achieve a quality improvement. This background colour often has to be printed 2-3 times.
It is very difficult to achieve grade 3 with this material type.

Metal-coated films demonstrate similar effects to labels with a metallic surface.

8.7.3 Cans

This material appears to the verification device (and the scanner) similar to metal-coated films or paper labels. If the barcode is printed in the 'picket fence' formation, the round shape of the can often causes metric problems (distortion over the rounded surface). The barcode is usually printed onto the can on a white background. Between the white, the black bar sometimes shows narrow metal lines next to the bars, which leads to defects and should be avoided.
Sometimes only the white is printed, and the bars left in relief. These bars act like a mirror and appear black to the scanner and the verification device. In practice however, it can happen that the cans become scratched, the metal does not reflect as necessary, or the scanner angle is unfavourable. This makes the verification and the scan results difficult to forecast. They vary from "Error" to "Very good". For this reason, REA recommends that this variation is not used.

8.7.4 Embossed metal film

This material is used for example for sealing yoghurt pots. This type of material should not be printed with barcodes, since the embossing alters the angle of the reflected light very unevenly, resulting in a poor or illegible barcode.
There are however now manufacturing processes in which the stamping of such films can be largely or entirely dispensed with.
Actually some metal film manufactures have replaced embossing by printing white pads on the back of the metal film. The metal film now has a flat surface and is useable for bar codes. Metal reacts to light like a mirror. This causes a reduced contrast because light will be reflected away from the sensor of a scanner or a Verifier.

8.7.5 Corrugated paper

Because of the paper used, corrugated paper usually has a brown, textured surface. The brown surface reduces the contrast. The light value of the brown surface can fluctuate greatly from one batch of cardboard to the next. The fibres of the paper produce a surface texture alternating between lighter and darker areas. This causes defects. The surface is normally slightly fluting. If barcodes are printed onto this surface, some bars are more heavily printed at the top of the fluting, making them wider than other bars.

Reader-pen verification devices such as the REA Check 3 are hardly or completely unsuitable for corrugated paper, since running the pen over a corrugated surface no longer functions correctly.

8.7.6 Plastic cups

Most plastic cups are coloured white. The modulation value is reduced on such cups, because the density of the plastic material is low. In contrast to plastic film, the packaging contents have little effect on the barcode contrast. Due to the wall thickness, the light reflected or absorbed by the packaging contents is negligible in comparison to the light reflected from the plastic wall.
Transparent plastic cups must be printed with a white field before application of a barcode. This then acts in the same way as for plastic film. In case white labels are used on transparent plastic pots quality is usually good. With white cups, the characteristics can be improved by using more pigments (master batch) in the plastic, or by using a plastic material with a higher specific density.

9. Standards and literature on barcode verification devices

- **Symbology specifications – Principles of the traditional evaluation**

  ISO/IEC 15420 Information Technology - Automatic Identification and data capture techniques – Barcode Symbology Specification – EAN/UPC
  ISO/IEC 15417 Information Technology - Automatic Identification and data capture techniques – Barcode Symbology Specification – Code 128.
  ISO/IEC 16388 Information Technology - Automatic Identification and data capture techniques – Barcode Symbology Specification – Code 39
  ISO/IEC 16390 Information Technology - Automatic Identification and data capture techniques – Barcode Symbology Specification – Interleaved 2-of-5

  The following older standards are being replaced by ISO/IEC standards.

  EN 797 Barcoding - Symbology specifications - EAN/UPC
  EN 798 Barcoding - Symbology specifications - CODABAR
  EN 799 Barcoding - Symbology specifications - Code 128
  EN 800 Barcoding - Symbology specifications - Code 39
  EN 801 Barcoding - Symbology specifications - Interleaved 2 of 5

  ANSI/AIM BC2-1995 : Uniform Symbology Specification - Interleaved 2-Of-5
  ANSI/AIM BC3-1995 : Uniform Symbology Specification - Codabar
  ANSI/AIM BC1-1995 : Uniform Symbology Specification - Code 39
  ANSI/AIM BC4-1995 : Uniform Symbology Specification Code 128
  ANSI/AIM BC5-1995 : Uniform Symbology Specification Code 93

  ANSI/UCC1-1995: UPC Symbol specification manual

- **Test specifications – Principles of the CEN/ANSI evaluation**
  ISO/IEC 15416 Information technology – Automatic Identification and data capture techniques – Bar code print quality test specifications – Linear Symbols

  The following older standards are being replaced by ISO/IEC standards.

  EN 1635 Barcoding test specifications for barcode symbols
  ANSI X3.182-1990 (R1995): Guideline for Bar Code Print Quality

  USA only EAN/UPC codes
  ANSI/UCC5-1995 Quality Specification for the UPC printed symbol

- **General information**
  EN 1556 Barcoding - Terminology
  EN 796 Barcoding - Symbology Identifier

ANS MH10.8.2:1995 - DATA IDENTIFIER and APPLICATION IDENTIFIER STANDARD

GS 1General Specifications
(Kit for the preparation of national guidelines)
Contains EAN 8,13, ITF, EAN 13 with add-on, EAN/UCC 128
EAN International, Rue Royale 29, B-1000 Brussels, Belgium, Tel. (32-2) 218.76.74, Fax (32-2) 218.75.85 or http://www.e-centre.org/EANUCC

Further information on the EAN data structures is available over the Internet from http://www.gs1-germany.de and http://www.gs1.org

- **Film Masters**
  ISO/IEC 15421 Information technology – Automatic Identification and data capture techniques – Barcode master test specifications
  ENV 13065 Bar coding – Test specifications for Barcode Masters
  UPC Film Master Verification Manual

Standard reference sources: Beuth Verlag GmbH, Burggrafenstr. 7, 10772 Berlin, Gemany http://www.beuth.de. In other countries the local national standardisation organisations supply standards.

10. Technical data

Power supply	100 to 240 Volt / 50 to 60 Hz Modifiable to international plug standards by interchangeable primary adapters	
Power supply, laser device	5.2 V max. 0.3 A	
Laser		
Laser class	Grade 2	
Wavelength	670 nm (alternatively 635 nm)	
Output	0.5 mW	
Pulse duration	25 µs	
Beam divergence	0.1 °	
Scan width	155 mm (optional 240 mm)	
Ambient conditions		
Temperature	5 - 40 °C (interior areas)	
Relative humidity	max. 80 % (non-condensing)	
Standards		
CE	Standards to Declaration of Conformity	
Laser safety	DIN EN 60825:1993	
Mechanical testing	Vibration:	IEC 68-2-6; DIN 40046
	Shock:	IEC 68-2-27; DIN 40046
Thermal testing	Constant cold:	IEC 68-2-1; DIN 40046
	Dry heat:	IEC 68-2-2; DIN 40046
	Varying temp.:	IEC 68-2-14; DIN 40046

Cleaning:

Clean the housing as necessary using a damp cloth.

Functional testing:

We recommend monthly functional testing using the test code supplied.

The use of a protective hood is recommended in dusty environments.

10.1 Safety instructions

Attention:
1. The laser device must be used only in an upright position, with the operating elements pointing upward!
2. The REA PC-Scan laser device may also be operated lying on its back, provided that the baseplate is facing away from the user, and the laser beam emitted upward cannot hit anybody.
3. Do not cover the power supply and the laser device! (Overheating danger)

Warning signs:

The following danger signs are to be found on the left side of the unit:

Laser-warning sign

Information label:
Laser radiation
Do not look into the beam
Laser Class 2

Laser class 2:
This laser class does not require any special protective measures.

Deliberate exposure of the eyes must, however, be avoided!

Laser units of Class 2 are low power units (< 1mW), emitting visible radiation. For up to 0.25 seconds of radiation these lasers can be considered harmless. In case a laser beam of Class 2 hitting the eyes by accident, eye protection is ensured by the eyelid closing reflex within less than 0.25 seconds and the aversion reaction.

As a direct safety requirement it is sufficient not to look deliberately into the beam.

Laser beam aperture:
The laser beam opening is at the bottom of the carriage. Angle of beam: 45° to the front.

Caution: Should other operating or adjusting devices than those stated in this manual be used, or should other ways of operation be carried out, this may lead to dangerous radiation exposure.

10.2 Declaration of Conformity

Declaration of Conformity

We

REA Elektronik GmbH
Teichwiesenstraße 1
D-64367 Mühltal-Waschenbach/Germany

declare under our sole responsibility that the product

Barcode verification device
REA PC-Scan

manufactured in our above production facilities in the year 2005 complies with the following standards:

- ISO/IEC 15426-1 Automatic identification and data capture techniques – Barcode Verifier conformance specification – Part 1 Linear symbols

  The barcode verification device REA PC-Scan is a device which includes the minimum functionality (mandatory) and the optional functions (optional).

- ENV 12647 Barcoding – Test requirements for barcode verification devices

  The barcode verification device REA PC-Scan is a grade A verification device to ENV 12647. The recommended functions listed in the standard, in excess of the required standard, are also fulfilled by the REA PC-Scan

These standards contain definitions of reference test symbols. The conformity is checked by means of these reference test symbols.

REA Elektronik GmbH
D-64367 Mühltal-Waschenbach

10.3 Declaration of Conformity

EG - Konformitätserklärung
Declaration of conformity
Déclaration de conformité

CE

Das Unternehmen / *The company* / La société

REA Elektronik GmbH
Teichwiesenstraße 1
D - 64367 Mühltal

bestätigt hiermit die Konformität des Produkts /
herewith declares conformity of the product /
déclare que le produit

Bezeichnung / *Designation* / Désignation	**Typ / *Type*/Type**
REA PC-Scan mit laser device	**REA Scan II / LD**

mit folgenden Bestimmungen /
with applicable regulations below /
est conforme aux dispositions suivantes valables en la matière

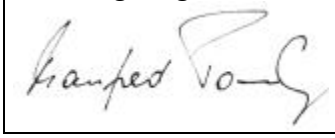
EG-Richtlinien / *EG Directives* / Diréctives CE
EMC directive 89/336/EWG amended by: 91/263/EWG; 92/31/ EWG; 93/68/EWG
Niederspannungsrichtlinie: 73/23/EWG amended by: 93/68/EWG

harmonisierte norms / *harmonized standards* / Normes harmonisées
EN 50081-1:1992; EN 55022:04.87
EN 50082-2:1995
EN 61010-1:1993

nat. techn. specifications / *national technical specifications*. / spécifications techniques nationales
VDE 0839 Part 82-2:04.94

Name / *Name* / Nom
Pauly, Manfred

Function / *Position* / Fonction
Geschäftsführer / *Managing Director* / Directeur

Ort / *Location* / Localité	**Datum / *Date***	**Rechtsgültige Unterschrift / *Signature***
Mühltal	**01.10.2005**	

11. Guarantee conditions

REA Elektronik guarantees that the devices supplied are free of material or manufacturing faults. This guarantee applies for 12 months from date of dispatch, and will be invalidated in the event of incorrect installation, improper use or damage to the device either by accident or neglect.

Repair under guarantee

If the device purchased fails to function properly within the above guarantee period, REA Elektronik will repair the device free of charge. In order to avoid unnecessary costs, you are requested to check the information contained in the operating instructions carefully before coming to the conclusion that the device is defective or not functioning properly.

Returning the device

The equipment case supplied must be used whenever returning the device for repair. The device must be returned at the cost of the sender, and suitably insured for the value of the device. REA Elektronik or its relevant representative will return the device carriage-paid following repair under guarantee. Express delivery can also be arranged if required. Express deliveries will be charged in accordance with the extra costs incurred.

General guarantee conditions

REA Elektronik cannot accept any liability for any indirect subsidiary or consequential damages, including damages resulting in loss of profit or production, delivery delays, material losses, increased operating or business costs etc.

Customer service following end of the guarantee period

For this service, please contact REA Elektronik or the representative responsible for your area.

Subject to technical amendment.

12. Index